COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. XVI | DECEMBER, 1911 | No. 12

Published by THE COMPRESSED AIR MAGAZINE CO., Easton, Pa.

NEW YORK, Bowling Green Building — LONDON, 165 Queen Victoria Street

Classified Buyers' Guide, Page 12. Index to Advertisers, Page 8.

INDEX TO ADVERTISERS.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XV DECEMBER, 1911 No. 12

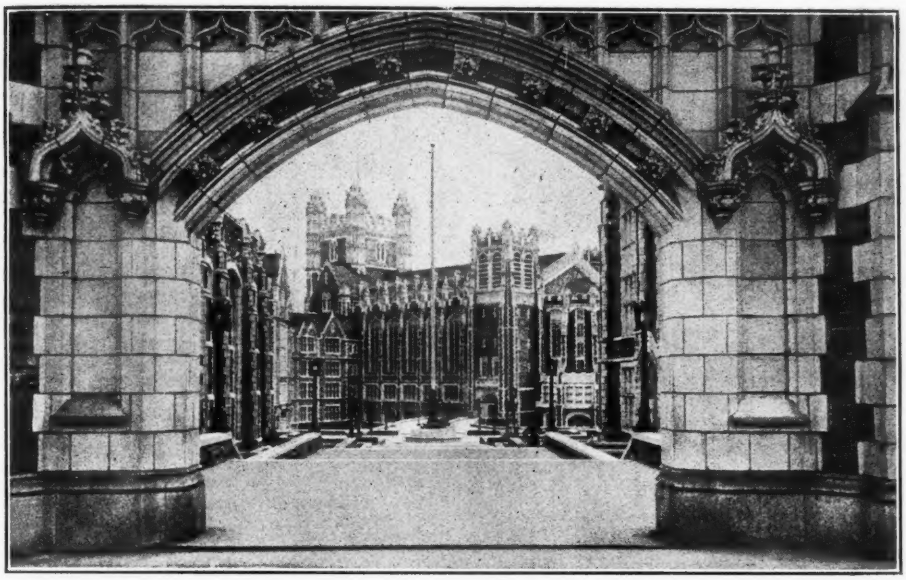

FIG. 1. ENTRANCE TO COLLEGE OF CITY OF NEW YORK.

SMALL DRILLS FOR A SMALL TUNNEL

The half tones here shown illustrate one of the minor or incidental compressed air jobs of which there are so many constantly coming on in New York City. The fine buildings of the College of the City of New York cover a large area upon ground a hundred feet or so above the normal city level but still with the cellars so low that they will not drain by gravity into the Washington Heights system of sewers. There is therefore a tunnel being driven to form a connection with the sewer in St. Nicholas Avenue. From the mouth of the tunnel here shown, which is in St. Nicholas Park, the sewer will be a cut-and-cover construction, all in rock, to St. Nicholas Avenue.

The plant for the job comprises an Ingersoll-Rand NF-1 steam driven compressor automatically maintaining a working pressure of 80 pounds and two Ingersoll-Rand B-104, 2½ inch drills, each weighing 116 pounds, mounted on double-screw columns.

The tunnel is 6 feet square, unlined. The average progress is 50 feet per week of six days. There are two working shifts, the first going on at 1 A. M. and finishing at 9 A. M. and the second starting at 11 A. M. and working until 7 P. M. Each shift consists of 11 men: 2 drill runners, 1 engineer for compressor, 1 blacksmith and helper and 6 muckers. The actual drilling time for each shift is 4 hours, during which time each drill accomplishes an average of 50 feet of holes 6 feet deep, starting with a 2 inch bit and finishing

with 1¼ inch. While designed for a depth of 6 feet they will easily do 8 feet. The contractor for this work is the Thomas Crimmins Company, of New York.

efficiency all through the details of machine-shop practice that there might be some question at the moment as to what most requires to be castigated for its delinquency, although I have little doubt about it.

FIG. 2. COMPRESSOR HOUSE RUNWAY AND DUMP.

COMPRESSED AIR THE LAST* DUCK OF THE MACHINIST

BY FRANK RICHARDS.

The simile of the last duck was used by a writer in the *American Machinist* many years ago in connection with some other matter. You know that in the big rivers of China there are many who live in boats and who keep lots of ducks. These ducks are allowed to swim away in the morning and to be gone all day, picking up their living, but they are all sure to return with a rush when night comes or when the owner calls them, because the last one is sure to get a whipping.

The *American Machinist,* without any formal or conscious recognition of the function, has kept up the whipping of the last machine-shop duck through all the years of its existence. The thing which has been most incorrect or inefficient in practice has constantly been set right and urged forward, until now there is such a general uniformity of

**American Machinist.*

In very recent years it has come in my way to offer a word or two here and there about compressed air, and usually in advocacy of its general and more extensive employment. My present breaking out is decidely in the same line. There may be those who, when they have read thus far, will think they have enough, but there really is something which ought to be said, and which should be heeded and acted upon for the good of all.

If, at the present time, compressed air is not the last duck in general machine-shop practice, and requiring the treatment which a last duck should receive, where else is that duck? Knowing in a general way the capabilities of compressed air, machinists still have not fully acquired the compressed-air habit. They don't *think* compressed air. They do not look upon it as a working companion, a constant helpmeet. When they do employ compressed air for any specific purpose, it is too apt to be as a last resort. There are some things, as we know quite generally, which only compressed air can do, but there are many other things which compressed air can

do better or quicker or more cheaply or with less fuss and muss than they can be done by any other agency, but this we do not so fully appreciate.

THE COMPRESSED AIR MISSIONARY.

In speaking here of the general machine shop, including its close ally the blacksmith shop, and of its too frequent lack of proper appreciation and its too infrequent employment of compressed air, both the manufacturing and the jobbing shops are included, and from the biggest down to those which are quite small, but practically all railroad shops are excluded from this category, for in all those the compressed air missionary has been located and has done its beneficent work so thoroughly that it can never be undone. There compressed air has come into its own and can never be dispossessed.

This missionary is, of course, the air-brake pump. With these pumps or compressors always hanging around ready for a job in all railroad shops, it has been the simplest thing in the world to pipe one up and to use the air for any of the primitive compressed air devices, as likely as not for an air hoist of some type, and then the handy air has at once made its way for other uses and has soon become indispensable. In the growing use of compressed air thus begun, it has frequently happened that one air-brake pump after another has been added, until sometimes a battery of eight or ten or a dozen has accumulated. The air-brake pump, as is conceded by all, is an extravagant and costly means of producing compressed air, though admirably adapted to the conditions of its normal employment. The steam or power cost of operating several of these pumps together has led to their replacement by standard and up-to-date compressors, so that railroad shops are now among the best customers of the compressor builders.

FIG. 3. MOUTH OF TUNNEL.

There has recently appeared a book of railroad-shop kinks of about 300 pages, each larger than the page of the *American Machinist,* and crowded all through with devices which have originated in railroad shops. Among these is an astonishing lot of air-operated conveniences and contrivances, all in established and successful use. These are devices which have all originated in railroad shops, have been first thought of and worked up and applied there. Most of them are equally applicable in all other machine shops, num-

bering, perhaps, four times as many as the railroad shops alone. These devices generally are not in the habit of being born, so to speak, in the shops other than railroad shops, because the air they breathe is not so free and plenty there.

The railroad man regards compressed air with confidence from the beginning, for he has constantly before him one of the world's greatest mechanical successes—the air brake. As a consequence he need not waste his time in hesitating as to the feasibility of any compressed-air application which may occur to him. Generally speaking, no experimenting is required. As soon as the thing is thought of it speaks for itself that it will work, and the only thing to be done is to determine the strength and sizes required and the general arrangement and adaptation of details.

COMPRESSED-AIR LEAKAGE.

With the air brake so well known, and with a general knowledge of its operation which every intelligent mechanic must possess, it remains an inexplicable mystery that there should be such a persistent impression, among those who have had little directly to do with compressed air, that in the general use of it there is a considerable and constant leakage. In the presence of a modern railway train it is impossible to discuss the matter. Take a train of, say, a dozen passenger cars, or, more trying still, forty or fifty freight cars with the air pipes coupled with a snap between each pair of cars by a not over-careful trainman, with valves and joints and fittings in each car. The pressure is maintained when the train is running and rattling along with the little air-brake "pump" working less than half its time, less than a quarter of its time, probably, and working not to keep up this constant pressure but to replace the air which is used each time the brakes are set. If there is so little loss by air leakage on railway trains, or on the miles and miles of piping in the switch and signal service, the possible losses in an ordinary machine shop are not worth talking about.

I have referred here only to the incidental uses of compressed air which develop in shops wherever a supply of air is constantly and freely usable. Compressed air is not primarily brought into shops for this service. It has its regular line of business in driving pneumatic tools, hoists, sand blasts, etc. Many of the most highly developed and most efficient machine tools call for air under pressure to operate feed motions and automatic devices, so that no shop can be uptodate, or can avail itself of the most advanced and most profitable of modern facilities without providing and maintaining an air supply. In the matter of providing this air service it is not a question of meeting the initial expense involved; the question rather is how the greater cost of operating without the air facilities can be longer submitted to.

The shop which is not a railroad shop has a great advantage to begin with, in that it is not tied to the steam gormandizing air-brake pump. The compressor manufacturers are now putting out machines in such great variety as to satisfy closely all requirements as to capacity, and the most suitable drive for the given conditions. Perhaps the most important thing of all in getting the first compressor is to provide one larger than the requirements in sight would suggest, for additional uses for the air will certainly develop. But, after all, it will be surprising how many air-operated devices a small compressor will drive where they are only intermittently operated. Compressed air is unique in that while it may be always standing ready to do its work it costs nothing except while actually doing it.

THE WORK OF THE HUMAN HEART

The average human heart is a suction and force pump of remarkable capacity and dura-antiquated diving methods employed on harbility. Each of its two chambers contains, on an average, 75 cubic centimeters, or 4.575 cubic inches; the total contents of 150 cubic centimeters or 9.15 cubic inches being discharged 81 times a minute, corresponding to a delivery of 12,150 cubic centimeters, or 741 cubic inches per minute, or 25.73 cubic feet per hour. Expressed in U. S. gallons, the average human heart pumps through it each hour 192.6 gallons; each day, 4,622.4 gallons; each year, 1,687,176 gallons; and in the adult life time of a man living to the age sung by the Psalmist 8,435,880 gallons. The pressure against which this fluid is pumped is equivalent to that of a water-column 2½ meters or say 8 feet 2.42 inches high; otherwise expressed, about 0.242 atmospheres or 3.55 pounds avoirdupois per square inch.—*Scientific American.*

THE METERING OF COMPRESSED AIR

By J. L. Hodgson.

Until comparatively recently the metering of compressed air has been looked upon as a problem involving considerable practical difficulties. At the present time, although it is not possible to assert that all these difficulties are removed, it is possible to say that practicable instruments are available by means of which the metering of compressed air may be effected with an accuracy of plus or minus one per cent.

Our confidence in the accuracy of the measurements is mainly due to the calibration plant belonging to Messrs. Eckstein, which was first erected to suit the author's requirements at Fraser & Chalmers' works at Erith, Kent. By means of this plant the various metering devices constructed to the author's designs by Messrs. Geo. Kent, Ltd., of London, were tested and calibrated. The plant is now re-erected at Ferreira, and serves as a permanent air standard for the Rand.

As this plant forms the basis of all the more recent measurement work, a brief description should not prove uninteresting. The air to be measured is passed through a large displacement meter, which is built somewhat on the lines of a steam engine. It has three cylinders 36 inches in diameter and the stroke is 27 inches. The air is admitted to and discharged from the cylinders by means of piston valves which are set to cut off exactly at the top and bottom of the stroke.

The stroke volume of the meter is 95.156 cubic feet. It therefore passes 50 lbs. weight of air per revolution at 100 lb. per square inch abs. and 513 degrees F. abs. The drop of pressure across the meter at full load is only about 1 lb. per square inch. For this reason, in designing it, no attempt was made to secure very small clearance volumes.* Owing to the small pressure drop across the meter, the leakage past the piston and valves is a minute percentage of the total weight passed.

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*South African Institute of Engineers (Abstract).

*If the clearance volume is 10 per cent. and the pressure of the air is 100 lbs. per square inch (abs.), a 1 lb. per square inch pressure drop across the meter will only cause an error of 1-10th per cent.

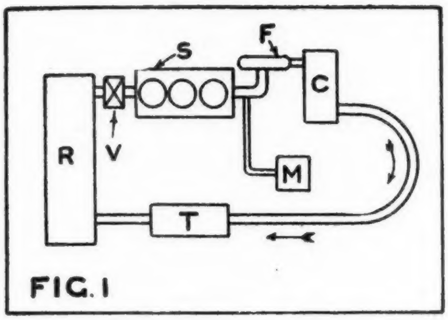


FIG. 1

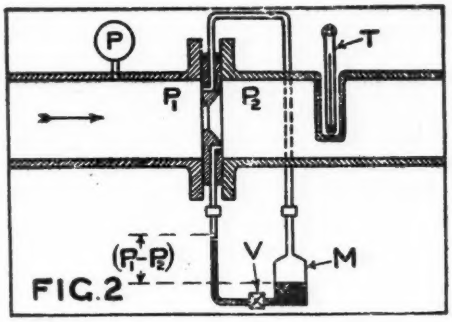


FIG. 2

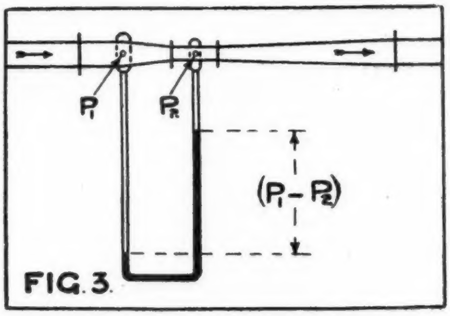


FIG. 3

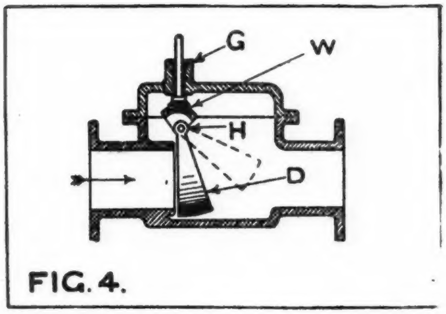


FIG. 4.

METERING COMPRESSED AIR.

Referring to Fig. 1, the air which passes through the meter to be tested T, and the standard meter S, is not allowed to discharge to atmosphere, but is circulated round and round in a closed air circuit by means of a single-stage Rateau fan F, which is capable of producing about 2.5 lb. per square inch difference of pressure at 4,000 revs. per min. with the air at 100 lb. per square inch. This arrangement enables a meter capable of measuring 2,000 h. p. to be calibrated with an expenditure of some 90 h. p. only.

The air, after leaving the Rateau fan, passes through a cooler C, by means of which its temperature is brought approximately to that of the surrounding air. A small compressor M is employed to compress the air in the circuit to any desired pressure and to maintain it at that pressure. A large receiver R was placed between the standard meter and the meter to be tested, in order to damp out the pulsations caused by the standard meter. It, however, proved entirely ineffective, and the pulsations were finally damped out, as far as possible, by placing the top valve V, by means of which the air following round the circuit was controlled between the two meters.

SIMPLE ORIFICE AND MANOMETER.

One of the simplest modes of measuring air flows in actual practical work is by means of an orifice and a manometer. This arrangement is show diagrammatically in Fig. 2. The air pipes are sprung apart and an orifice O, about 5/8 in. thick, is placed between the flanges. Upstream and downstream pressure holes are provided in the orifice, as are also provisions for a pressure gage P and a thermometer T. The difference of pressure between the upstream and downstream sides of the orifice are measured on a manometer M, and from its readings and the pressure and temperature of the air the flow may be determined. In order to facilitate reading, one limb of the manometer is made in the form of a large reservoir, so that almost the whole of the change of level of the liquid takes place in the other limb. A contracted scale is employed to enable the true change of level to be read directly on the one limb. A throttle valve V is placed between the two limbs to damp down pulsations and to prevent the liquid being blown over when the manometer is being connected up. In arranging the pipes between the manometer and the orifice it is best to avoid U bends in which water may collect. If these are unavoidable, blow-out cocks must be fitted at the lowest points.

The discharge formula for any particular orifice is of the form:—

$$Q = K\sqrt{\frac{P_1\ (P_1 - P_2)}{T_1}} \text{ lbs. per sec.}$$

where K is a numerical constant.

P_1 and T_1 are the absolute pressure and temperature of the air at the orifice.

$(P_1 - P_2)$ is the difference of pressure across the orifice.

It will be noticed that the orifice O is sharp edged instead of being rounded or curved. It was found that if the orifices were made with rounded edges, slight variations in the curvature caused very considerable alterations in the value of the co-efficient K. As it was necessary to be able to calculate the discharge, a sharp-edged orifice, which can be reproduced with ease and precision, was adopted. The tests have shown that the discharge through these orifices can be calculated to within 1/2 per cent.

Orifices of this type have been installed for metering the compressor discharges at the Rosherville and Robinson Central Stations of the Victoria Falls and Transvaal Power Company. In this case they measure the discharge through air mains 12 inches in diameter. They are, however, equally applicable for measuring the air supplied to single drills which passes, say, through a 1 in. pipe. If orifices are installed at various points in a compressed air distribution system, the discharges can at any time be determined by means of a portable manometer.

A CHEAP COUNTER METER.

A cheap form of counter-meter, with automatic pressure correction, is also being designed for use in conjunction with these orifices, so that a continuous measurement of the air supplied to the various levels in a mine may be made. By tabulating the air used per drill per shift for each level, inefficient drills and wastage due to bad joints and open cocks can be detected.

THE VENTURI METER.

The principal disadvantage of the orifices just described is that only a small proportion of the pressure difference $(P_1 - P_2)$— which is used as the basis of the measurement

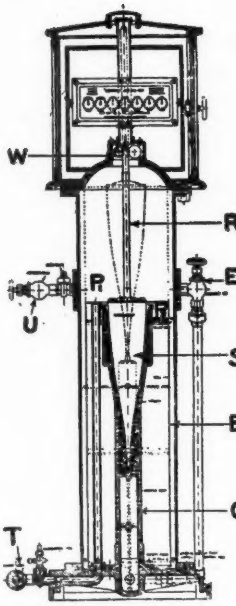


FIG. 5. VENTURI TUBE METER.

—is recovered. The Venturi tube (Fig. 3) effects the measurement in essentially the same manner, but owing to the long, tapering case on the down stream side, the formation of eddies is avoided, and a very much larger proportion of the pressure drop ($P_1—P_2$) is recovered.

The discharge formula for the Venturi tube is of the form:—

$$Q = KA_1 \sqrt{\frac{P_1 \ (P_1 - P_2)}{T_1 \ (N^2 - 1)}} \text{ lbs. per sec.}$$

where K is a numerical constant.

A_1 is the cross-sectional area of the air main.

P_1 and T_1 the absolute pressure and temperature of the air at the Venturi tube.

($P_1—P_2$) the drop of pressure between the full diameter and the throat.

N the ratio of the area of the upstream to that of the throat—called the "throat ratio."

The value of the co-efficient K was determined experimentally on the calibration plant for all diameters of Venturi tubes between 3 ins. and 20 ins., and for all the throat ratios that commonly occur in practice. As a result of this work the discharge through these tubes can now be calculated with extreme accuracy, and they form a very simple and reliable secondary standard for air measurement. The meters at present supplied to the Victoria Falls and Transvall Power Company all involve the use of the Venturi Tube, but owing to it being possible to simplify the erection and installation of the meters by adopting an entirely different method of measuring the air flow, meters of this new type will in future be supplied for air mains above six inches in diameter, instead of those involving the use of an Orifice or a Venturi Tube. The Venturi Tube meters have, however, a permanent sphere of usefulness in the measurement of the large volumes of coal gas used for town supply. Messrs. Geo. Kent, Ltd., of London and Luton, have already installed several of these meters in England and in Australia with very considerable success.

The main practical difficulty with regard to the gas has been the deposition of tar or napthelene in the Venturi Throat. This difficulty has been successfully overcome by putting a steam or hot-air jacket round the throat; thus keeping the surfaces warm and so preventing the condensation of the various impurities in the gas.

In the Venturi Tube meter the difference of pressure ($P_1—P_2$) is measured by means of a light inverted bell B (Fig. 5) immersed in an oil-seal, the throat pressure (P_2) acting on the underside of the bell, and the upstream pressure (P_1) on the outside. An increase of flow causes the bell to sink. The weight of the bell is taken by a carrying float C, made of vulcanite and slate (in order to compensate for changes in temperature), which is always totally immersed in mercury. The amount of movement of the bell is determined by the shaped float S, the bell descending until the difference in pressure ($P_1—P_2$) is balanced by the buoyancy of the immersed portion of the shaped float. The bell carries a rack R, by means of which its motion is transmitted to a wheel W, and from thence through a gland to a cam placed outside the bell chamber. Owing to the shaped float being made long and tapering, the arrangement is extremely sensitive at low values of ($P_1—P_2$): giving an inch of motion when ($P_1—P_2$) changes by 1-1,000th lb. per square inch, and being perfectly sensitive to variations of pressure of less than 1-10,000th lb. square inch. The upstream throat and equalizing cocks are shown at U., T., and D.

A drawing of the Venturi Tube as supplied

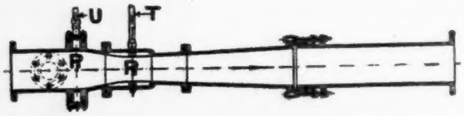


FIG. 6.

to the Victoria Falls and Transvaal Power Company is shown in Fig. 6.

A SIMPLE DIAGRAM RECORDER.

A small diagram recorder which can be used in conjunction with either the Orifice or the Venturi Tube is shown in Fig. 7. A

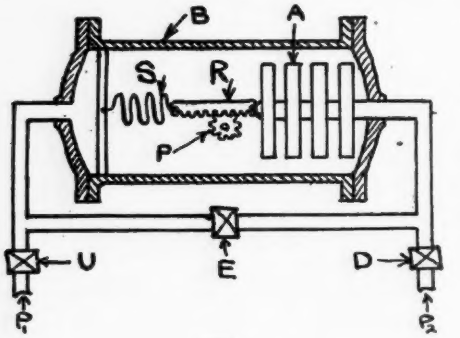


FIG. 7.

battery of aneroid diaphragms A (Fig. 7) are enclosed in a pressure-tight box, B. They are kept in tension by the spring, S, and any movement is transmitted by the rack, R, to the pinion, P, to which a pen arm is attached. The inside of the diaphragms is in communication with the downstream pressure, P_2, while the outside is subjected to the upstream pressure, P_1. An increase of (P_1—P_2) therefore causes the diaphragms to collapse. The intrument is provided with upstream and downstream and equalising cocks, U, P, and E respectively. By closing U and P and opening E the accuracy of the zero can at any time be tested. The instrument may also be arranged to correct automatically for variations in pressure. It forms a very simple and reliable diagram meter for measuring air or steam flows.

THE "WEIGHTED DOOR" METER.

The type of meter which is now being adopted for the larger-sized air mains on the Rand consists of a weighted door D, Fig. 4, swung on horizontal hinges H, placed in the air main. The motion of the door, which is a measure of the flow passing, is transmited out through the top of the meter case by means of the two bevel wheels W, and the gland shown. The weighted door thus replaces the orifice and manometer, or the Venturi Tube, and the oil sealed bell. Although this instrument looks, and actually is, extremely simple mechanically, it is somewhat expensive to manufacture. Felt protected roller bearings are used to carry the weighted door, and dashpots are provided on each side of the meter to damp down the oscillations of the door. Then, in addition, although it is possible to design the meters so that the body casting is of the correct size, it is quite impossible to calculate the discharge for each position of the door beforehand. Each meter therefore has to be calibrated; but when all this has been done the measurement of the air is extraordinarily simple and easy.

The "weighted door" meters have a very much greater range than the orifice and the Venturi meters. By suitably shaping the cavity in which the door swings it is quite possible to measure down to 1-100th of the full flow. With a manometer it is difficult to measure less than 1/8 of the full flow. Even on the elaborate and carefully designed meters of the V. F. & T. P. Co. it is impossible to measure much below 1-30th of full flow. Another advantage of this type of meter is the case with which its capacity may be changed. All that has to be done is to alter the loading of the door and to put a new change wheel in the counter train. Although the weight-door meters are more troublesome to construct than are those of the Venturi type, they are in every way more desirable from the user's point of view.

PNEUMATIC TROLLEY CAR TRACK SCRAPERS

The Root pneumatic equipment for double truck cars, made by the Root Spring Scraper Company, Kalamazoo, Mich., consists of an air cylinder fastened to the truck of a car, operating a Root spring scraper, and controlled from the platform by means of a three-way air valve. The reason for installing in this way, where there is space enough for the scraper to swing on curves and not interfere with the steps and other equipment, is that the scraper follows the rail much better on curves than when fastened to the body of the car. The Root scraper equipment and the air cylinder may, however, be attached to

the frame of the car, the air pipes being carried from the scraper air cylinder to the platform of the car, where it is controlled by a three-way valve. On city cars that are equipped with air this is a very important improvement as it does away with the wheel and the staff on the platform. It can be adjusted so that any pressure required can be applied to the scrapers, and when the scrapers are not in service they are safe from falling down at either end of the car. When it is desired to use the scraper the motorman has only to turn on the air which holds the scraper to the rail and when the air is released the spring on the inside of the cylinder holds the scraper up out of commission. This scraper is designed to meet the requirements of the pay-as-you-enter car, on which type of car the windlass rod is dispensed with.

POWER FROM COMPRESSED AIR

By H. Macintire.

In the transmission of compressed air local conditions are the all-important factor, and these conditions will affect the laying out of the pipe line to the same extent as in power-station design in different parts of the country.

The loss of head or pressure has been found to be proportional directly to the density and the length of pipe, as the square of the volume discharged and inversely as the diameter in inches. In other words, the economy of transmission depends, exactly as in the transmission of direct-current electricty, on how much capital is to be tied up in the first cost. For example, in driving the Jeddo mining tunnel a 6-inch main was used to convey the air power to two 3¼-inch machine drills over a distance of 10,900 feet and the loss of pressure was only 0.002 pound, a practically negligible loss. However, it would not be economy usually to design a pipe for such low velocity of the air, as the interest and depreciation on the additional investment over the cost of a smaller pipe line would more than counterbalance the saving in fuel, unless a future demand should make a decided change in the conditions.

In designing the transmission line, therefore, reasonably definite consideration must be given to the future. The pipes, as a rule, are run underground, and are difficult and costly of access. It costs to pass a certain volume of air through a length of 1-inch pipe over three times the head necessary to carry the same volume through the same length of 2-inch pipe, for the periphery increases as the first power and the area as the second power of the diameter. Therefore, as the demand comes on for extra power and an extra pipe is required, the loss of head in the two pipes would be greater than the loss occasioned by a single pipe of an internal area equal to the sum of the areas of the two pipes. The ratio of the periphery to the area of the transmission pipe is the important point affecting friction loss of head. Besides the diameter, the factors affecting loss of head are: The condition of the inner surface, the kind of joint employed, the number of valves and bends, and other factors of like nature. Although a number of tests on the mains in Paris and elsewhere have been made, the data obtained have not been full enough to enable any but approximate calculations. The allowable velocity, however, was clearly brought out. In each case with an initial pressure of 100 pounds, it was found that a loss of 2.4 pounds per mile in the pressure occurred with a velocity of 25 feet per second, 9.4 pounds per mile with 50 feet per second, and 46.2 pounds per mile with a velocity of 100 feet per second.

Many of the precautions taken in laying out a steam-pipe line are required for air transmission. The joints must be carefully made so as to prevent air leaks and to eliminate friction as far as is possible; allowance must be made for expansion and contraction, especially if the pipe is carried above ground; pockets in the line without means of emptying the segregated moisture must be avoided, and, finally, provision must be made for repairs on the pipe should these be necessary.

Some time ago, when the question of air versus electric power was being considered, one important argument in favor of air was that the steam engine could be used with but slight changes in the valve gear when operating with air instead of with steam as the woking medium, whereas, of course, electric power requires absolutely new machinery. The indicator diagram for air is almost indentical with the steam diagram. When used, however, as is done now almost entirely, to drive special tools, this argument in favor

of air will not hold, as pneumatic tools have been designed for air power only.

In general, then, it can be said that the air motor, or machine, is one specially designed for the working fluid. The pneumatic tool cannot be easily described because of the great diversity in the varieties of makes. It uses, however, a pump diagram; that is, it takes air for the whole stroke, exhausts at the end of the stroke, and in consequence is not economical.

Moisture in the air has harmful effects during expansion unless some means can be had to prevent the temperature from going below 32 degrees Fahrenheit. During expansion the temperature drops, the expansion being almost exactly adiabatic, to a greater or lesser degree, according to the conditions. With an initial pressure of 75 pounds, and using a pump diagram, the discharge temperature will be—60 degrees Fahrenheit, but when expanding to the back pressure an economical diagram will be obtained and the temperature will be—144 degrees Fahrenheit. This reduction of temperature is very inconvenient because of the impossibility in practice of removing all the moisture in the air, and of the remainder freezing during exhaust. This fall in temperature can be prevented by injecting steam into the air at admission or by reheating. In the case of the addition of steam, its latent heat is given up during expansion and the temperature of exhaust can be kept above 32 degrees Fahrenheit. However, in many cases steam is not available; if it is available it can be used to drive the motor itself.

The second method—that of reheating—is very practical. A coil of pipe similar to those used for superheating steam is usually placed over a coke or charcoal fire and the air is increased some 300 to 400 degrees in temperature at constant pressure. As, however, dry air is slow in taking up heat from dry walls, water is sometimes sprayed in. The effect is twofold: First, the troublesome fall below the freezing point is avoided, and, second, a great increase in efficiency is obtained. The increase in work is about six times what could be obtained from a first-class steam engine at a minimum first cost. Prof. J. T. Nicholson in experimenting with a 27-horsepower Corliss engine, with air at 53 pounds, found that 850 cubic feet of free air was required per horsepower-hour, and dry reheating to 287 degrees Fahrenheit reduced this to 640 cubic feet, or a gain of 25 per cent. The same test showed that 1.42 pounds of coke per hour were required for each additional horsepower, a result which will compare very favorably with good steam-engine practise.

ECONOMICS OF AIR TRANSMISSION.

So far the discussion has been confined to the means of obtaining power from an air system and certain problems arising therefrom, but now the economics of its use and an idea of its possibilities will be considered. The best idea of its economy can be obtained from the plant in Paris, which has been very carefully tested.

These tests have made the Paris plant very economical. The compressor has an efficiency of from 75 to 80 per cent., the transmission line of 95 to 98 per cent., and the motor, of the best design, from 75 to 80 per cent. The poorer designs of motors, or those badly worn or adjusted, will show as low as 10 per cent. The Paris plant therefore shows that good economy can be obtained with air as the motive power.

Not only is the economy very high, but the uses to which air power can be put are almost without number. These include all kinds of mining tools, the pneumatic tools used in ship, bridge and boiler construction; pneumatic engines for mining and power-mill traction work, subway and tunnel work where compressed air is used to prevent the ingress of water; for refrigeration to a small extent, and as a means of pumping water (as in the Pholé air lift).

The advantages of using air are many: It is cheap; there is no danger of explosion from air alone; it is reliable; no insulation is required, nor will the transmission line heat its surroundings. In mining or other confined quarters the exhaust can be used for ventilation. Air replaced steam at the Cleveland Stone Company's works with a daily saving of about 49 per cent.

The great difficulty is lack of flexibility and large first cost. To design an economical plant, either the demand for power must be definite and unvarying or the gift of prophecy must be in evidence. Besides this, the size of the pipe line and the engine is very much larger than electric power would require for the same power, and the difficulty

in maintaining the transmission line is greater.

Air power, however, has its own particular sphere, in mining and quarrying, and in all probability it will be found there for some time to come.—*Power.*

LIQUID AIR RESCUE APPARATUS AT THE MAKIEWKA (DONETZ) RESCUE STATION

By D. Lewitsky.

The problem of the application of liquid air in rescue work was solved by M. Süss, the inventor of the Aerolith apparatus; but in spite of the interest aroused by this apparatus in all who are interested in such work, the apparatus itself has not made any headway.* The reason for this is to be found in the difficulties in the way of transporting and storing the liquid air. Moreover, in spite of its advantages, the lightness of the apparatus and the agreeable temperature of the air inhaled, the Aerolith is attended with serious drawbacks resulting from the fundamental idea on which it is based. The Aerolith is a reservoir apparatus, since the air inhaled by the wearer is obtained by the vaporisation of the liquid air in consequence of the influx of external heat, the quantity of the gaseous air resulting from such vaporisation is not constant but gradually diminishes, so that one is faced with the problem of how the effect of the Aerolith calculated that the conditions of vaporisation of the liquid air would themselves prevent the uncomfortable results of this fact, for though the quantity of gaseous air obtained from the liquid air decreases progressively, the percentage of oxygen in same goes on increasing. On the other hand, the peculiarities of construction of the apparatus were intended to afford the possibility of regulating the quantity of air vaporized. The *diagonal* tube traversing the liquid air reservoir and forming a conduit for the exhaled air, was intended to transmit the heat received from that air to the liquid, and thus assist vaporisation. Practical experience, however, shows that the sides of this tube are very quickly covered by deposited flakes of solid carbon dioxide, whereby the transmission of the heat to the liquid air is retarded; and it is possible that, even apart from this circumstance, the heat would not be transmitted very completely to the liquid air. Hence the first transmission was only based on hope. Moreover, the physiological phenomenon of respiration was investigated from the chemical side only, the mechanical side being overlooked. Experiment has shown that the human lungs require a certain minimum volume of air, below which it is impossible to go; and this minimum may be taken as about 1,200 to 1,500 cubic inches per minute. Now, if the volume of air supplied by the Aerolith apparatus falls below this limit, it follows that the lungs are compelled to obtain the remainder from wherever they can; and in these circumstances they inhale the partially vitiated air contained in the breathing bag. As the experiment is continued, the amount of pure air, although enriched with oxygen, still goes on diminishing, and that of the vitiated air progressively increases, so that the air inhaled becomes very rich in carbon dioxide. Thus it was found that during the first hour of wearing the apparatus, work could be performed with ease, but less so during the second hour and particularly towards the end; whilst if any strenuous work has to be done in the second hour the situation becomes critical.

Another liquid air apparatus investigated at Makiewka is that of G. Claude, who bases on the idea that—contrary to older opinion—oxygen is not injurious for respiration, the orагnism consuming as much as it needs. On this account, Claude constructed his apparatus for 1½ litres of liquid air. It is evident that, here also, the above mentioned minimum limit has been left out of consideration. The result showed that the apparatus is unsuitable for rescue work. Hence the existing apparatus for liquid air (or oxygen) do not satisfy requirements so far as construction is concerned.

The author has made experiments with a view to solving the problem from a different starting point, and decided on the construction of a regenerative breathing apparatus for liquid air, the regeneration being effected by purely physical and not chemical processes. In this apparatus the exhaled air is allowed to pass through the liquid air, whereby two

*For example, the Makiewka rescue station is provided with five sets of Aerolith apparatus, but has never used them, although a Linde oxygen plant is available.

purposes are fulfilled—namely, that the exhaled air is freed from carbon dioxide—which falls, in the state of a hard white powder, on to the bottom of the reservoir, and at the same time the heat of the exhaled air assists in vaporizing a portion of the liquid air (this liquid air should be rich in oxygen), the exhaled air becoming mixed with the vaporized air, rich in oxygen, and again suitable for respiration. It is possible that the process is very complicated. For example, it may be that when such portion of stratum of the exhaled air as comes in contact with the sides of the metal tube traversing the liquid, attains the temperature of the liquid air, a portion of the nitrogen in the gaseous air, in its passage through the liquid air, may displace a portion of the oxygen of the latter. A result of this kind is, at first sight, unexpected, though it will become clear if one remembers that when gaseous and liquid mixtures of nitrogen and oxygen are left in immediate contact, there is always a certain equilibrium for gaseous and liquid mixtures. For instance, the liquid mixture containing 50 per cent. of oxygen is in equilibrium only with a gaseous mixture containing 21 per cent. of oxygen; whilst the liquid mixture containing 70 per cent. of oxygen is in equilibrium with a gaseous mixture containing 41 per cent. of oxygen, in accordance with the subjoined diagram compiled by M. Baly, showing that the liquid mixture may be in

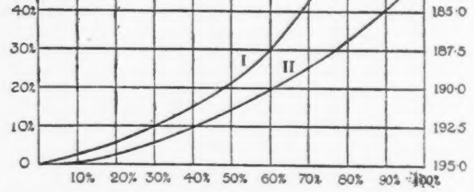


FIG. 1.—BALY'S DIAGRAM.

I. The maintenance of the oxygen in the gas as a function of the maintenance of the oxygen in the liquid air.
II. The temperature of the liquid.

equilibrium with such gaseous mixtures as it liberates during its own vaporisation (confirming the interesting experiments carried out by G. Claude in his work *L'Air Liquide*, p. 342-43).

If this process be allowed to take place even in part, the result is the same, viz., the air for breathing is obtained in a beneficial condition, rich in oxygen. In addition, it gives the advantage that a given amount of liquid air will last for a longer time than in apparatus of the reservoir type, because the exhaled air is re-inhaled at once. This, however, might *a priori*, appear incomprehensible, the question arising whether the vaporisation of the liquid air does not proceed too rapidly in the apparatus, in consequence of the heat transmitted from the exhaled air. The theoretical aspect of the case is difficult to establish, but may be illustrated by an experiment. The heat of evaporation of liquid air is about 50 calories (48 calories for nitrogen and 51 calories for oxygen). The specific heat of the gaseous air, increasing as the temperature falls, may be taken as ¼ calorie on the average. Hence, if we take 5 litres of liquid air, this quantity will be sufficient to cool down to—200 degs., a volume of gaseous air equal to 800 times that of the liquid air, and, therefore, 4,000 litres. If the temperature of the exhaled air were actually reduced to—200 degs., and the volume of air exhaled amounted to 50 litres per minute, then the above quantity of liquid air would be sufficient to last for $4{,}000 \div 50 = 80$ minutes. As a matter of fact this calculation is disturbed by other factors, some tending to lengthen the period, and others to shorten it. In the first place, as a matter of fact, a portion of the air is vaporised by the influx of heat from outside; and secondly, a certain amount of heat is absorbed from the carbon dioxide in solidifying, both of which circumstances reducing the effective working time of the apparatus. On the other hand, however, the exhaled air is not cooled down to such a low temperature as given above; so that, as the experiments carried on at the Makiewka station have demonstrated, the 5 litres of liquid air enable work to be done for more than two and a half hours. This result is due to the following circumstances:—On commencing work with the apparatus, the circumambient temperature vaporizes such a

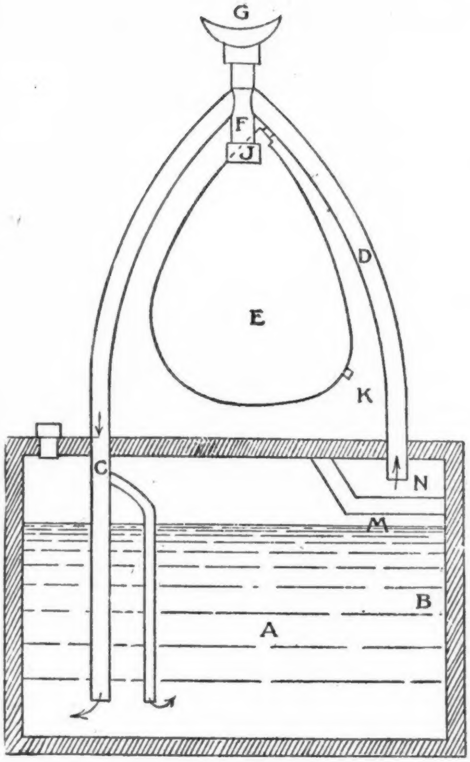


FIG. 2.

quantity of the liquid air that it is unnecessary to pass the whole of the exhaled air through the liquid, a portion being allowed to escape through a relief valve. This gives the following advantage:—Among the drawbacks of this apparatus must be included the necessity for passing the exhaled air through the liquid air, since this passage increases the difficulty of exhaling as compared with inhaling. Now, it is just when the difficulty of exhaling is greatest, owing to the height of the column of liquid, that the larger portion of the exhaled air can be discharged through the relief valve. Although in this way the volume of air discharged is regulated automatically, diminishing in proportion as the height of the column of liquid decreases, it has been found useful to provide the valve with means enabling its rate of delivery to be modified by hand.

To prevent spilling the liquid air, the apparatus is fitted with partitions, leaving free passage at alternate ends. In addition to the risk of spilling, there has also to be considered that of excessive vaporisation of the likquid air in consequence of sudden turns and bendings; but it is believed that these defects can be minimized by covering the liquid air reservoir with insulating material. A further drawback of the apparatus resides in the valves; to prevent them from freezing up, metallic heating devices have been provided.

In spite of these defects, the experiments carried out with the apparatus at the Makiewka rescue station gave satisfactory results. One good feature is that when heavy work is being done a good supply of air is always obtainable (good regulation); and the proportion of carbon dioxide in samples of exhaled air from the bag does not exceed ½ per cent. in any case.

In the apparatus (fig. 2) the reservoir A has double metallic walls B, between which the insulating material (such as glass wool) is placed. A flexible metal pipe for the exhaled air is screwed on to the tube C, which is branched in order to secure better distribution of heat in the liquid air. The vaporised air, together with the purified air (the carbon dioxide from which falls to the bottom as a white precipitate) passes through the flexible pipe D into the mouth. The superfluous air flows into the bag E. F is the divider, and G the mouthpiece (which may be replaced by a mask).

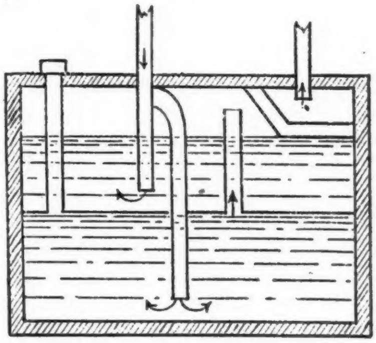


FIG. 3.

The surplus quantity of exhaled air escapes outwardly through the valve J. The bag is fitted also with a storage valve K. M N are partition walls which prevent the liquid air from spilling over when the wearer stoops.

The construction of the apparatus has been modified to some extent recently, as indicated in Fig. 3. The reservoir is divided horizontally so as to reduce the difficulty of exhaling by one-half since the height of the

column of liquid has been lowered to an equal extent.

The attention of the author has recently been drawn to the existence of the apparatus described in English Patent 17589 (1910), working with liquid air and chemical purification. Being desirous of trying the apparatus, but unable to obtain a set in commerce, the author had one constructed in accordance with the details given in the patent specification. The trials, which are not yet completed, have given satisfactory results, the apparatus working better than the Aerolith. The inventor of the said apparatus is of the author's opinion that rescue apparatus operating with liquid air should be of the regeneration tpye, and not of the reservoir type exclusively. Whether, however, the regeneration is to be effected by chemical or physical means must be left for the future to decide.

MINE FARMING

The hanging gardens of Babylon may soon have to give way to the underground truck farms of Mexico if an experiment recently made by a Chihuahua miner becomes generally prevalent in the mining districts of that country. An Almoloya miner has found out that he can save a great deal of time over the putting together of a lettuce leaf sandwich for his lunch, or the occasional partaking of a luscious raw tomato, without having to go to the surface to satisfy his tastes. All he has to do, and he has done it, so he says, is to bring down some good top soil into the mine, plant the seeds and Nature will do the rest, due to the even temperature which prevails in the mine. As a result of this experiment, this progressive miner has a fine truck farm growing down in one of the old levels of his mine, and so far has produced a diminutive but at the same time a satisfactory crop of potatoes, onions, lettuce and tomatoes. All that is necessary is to take down some planks and on these spread about an inch of good earth, place large potatoes in this without covering and at a good distance apart, they will soon sprout and all the work necessary is to keep the suckers and leaves cut off. The potatoes grow to a good size and having been grown in the dark have practically no skin, are dry and mealy and of excellent flavor.—*Mexican Mining Journal.*

A TURBO COMPRESSOR HELPS A RECIPROCATING PISTON MACHINE

BY C. VAN LANGENDONCK.

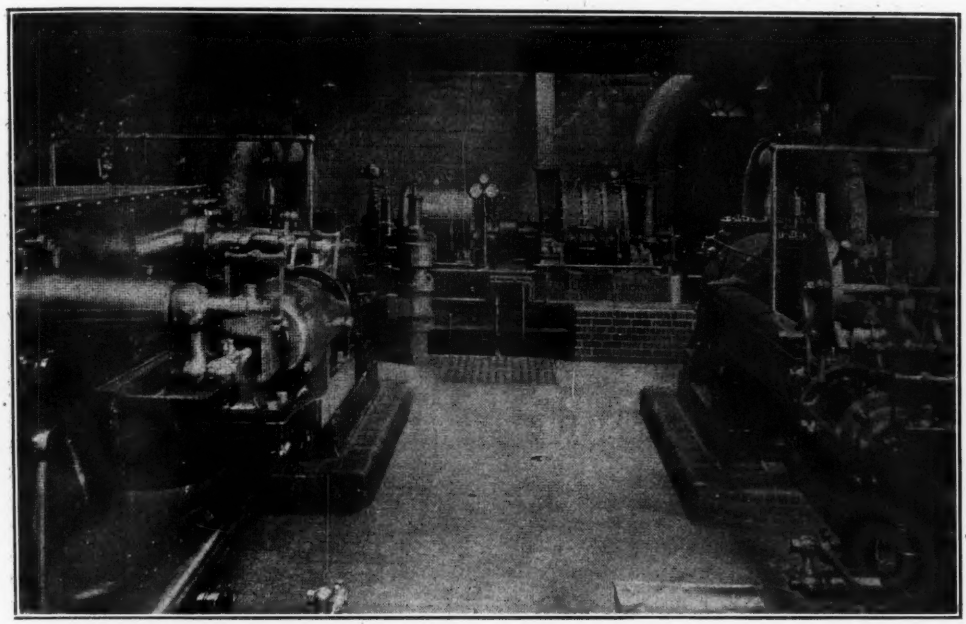
It is often a very difficult matter to know what to do when, owing to the growth in size of industrial establishments, their power plant, which, in the beginning was more than ample, is not more adequately fulfilling the demands that are made upon it.

A case of the kind recently arose at an English colliery, where in order to meet the increased demand for air, either the existing piston-compressed air plant—a cross-compound engine with cylinders 28 in. and 50 in. in diameter by 60-in. stroke, driving duplex air-cylinders of 33-in. diameter, running up to from 30 to 35 revolutions per minute as a maximum—could be augmented by a similar set, or, with a view of increased efficiency on the air cylinders, by the installation of a compound two-stage compressor, or finally by the adoption of a turbo-compressor set receiving its driving energy from the exhaust of the low-pressure steam-cylinder.

Here the plan contemplated was that the turbo-compressor should pass its discharge through an intercooler into the existing air cylinders. It was found that the cost of the second piston compressor would very much exceed the first cost of the turbo-compressor installation and would also occupy much more floor space. Moreover, a gain of efficiency could be obtained only with the new piston compressor plant, whereas the turbo-compressor would improve the working efficiency over the whole combined capacity. For these reasons, therefore, it was decided to install the turbo-compressor.

The complete arrangement is shown in the accompanying illustration, and it may be said that the results have fully justified this decision; a gain of about 17 per cent. over what would have been secured from a second piston compressor having been obtained.

The turbo-compressor is of the Rateau type, and easily delivers from 6,000 to 7,000 cubic feet of free air per minute at a pressure of 12.8 pounds per square inch by gauge. The steam consumption claimed for the turbine was also established. The flexibility of the plant was particularly noteworthy, as outputs up to 12,000 cubic feet per minute, and pressures up to 16 pounds per square inch



TURBO COMPRESSOR TO HELP PISTON MACHINE.

were easily realized. When running the existing piston compressor at the normal speed of 30 revolutions per minute, taking in air at atmospheric pressure and temperature, the maximum volume discharged at 60 pounds was 3,000 cubic feet per minute of free air, while, with the addition of the turbo-blower set, and with the same number of revolutions of the piston compressor, an increase in the free air capacity of over 100 per cent. was obtained, and the total efficiency both of the air and of the steam end was greatly improved.

The low pressure steam cylinder of the existing duplex piston compressor now discharges into a large steam receiver, an old boiler shell with automatic relief valve arranged so as to prevent undue accumulation of pressure. From this the steam passes through the exhaust steam turbine to the condenser arranged underneath the turbine exhaust branch. The turbine is absolutely under the control of the reciprocating compressor, as a demand for more work from the plant requires more steam from the duplex compressor, and provides the turbine with the necessary steam for the required air capacity or pressure. A butterfly emergency valve is arranged between the turbine stop valve and the turbine wheels; it is closed automatically when the turbine speed reaches a predetermined limit of about 4,200 revolutions per minute, but opens again when the steam supply and the speed have become normal. The butterfly emergency valve is also automatically closed should the oil pressure to the bearings become insufficient, thus preventing heating of journals.

The Rateau turbine is of the multicellular type, the cylinder of which is divided into a number of compartments, in each of which are fixed the distributing vanes. It is of the "Action" type, the fall of pressure taking place in the distributors only, the expansion being utilized to create kinetic energy. As the pressure is the same on both sides of the moving wheels, balancing pistons are not required as in "Reaction" turbines, where the fall of pressure takes place partly in the moving wheels. A Rateau type of centrifugal multi-stage blower is also used. Diaphragms are placed between the wheels and take the air at the outlet of each wheel and lead it through channels of special shape into the eye of the next wheel after having transformed the velocity head into pressure head. —*National Engineer.*

VARIOUS PNEUMATIC DEVICES

Upon the opposite page are grouped a number of cuts of pneumatic devices which have recently appeared in our exchanges.

Fig. 1., from the *Scientific American,* shows a kind of home-made apparatus for spraying gasoline for cleaning automobiles. It consists of a galvanized tank *E* provided with a tube soldered into it at the top, and another one at the bottom. These tubes are fitted with valves *C* and *H*. The tubes are joined and are connected by means of a ⅜-inch hose *B* of any suitable length, say twenty feet, to a nozzle *A*. The nozzle should be provided with a quarter-inch aperture and a flared outlet. A bicycle pump *D* is connected with the tank at one side and a pressure gage *G* is secured to the top. In use, a gallon of gasoline is poured into the tank, as indicated at *F*, and then the pump is operated to produce a pressure of several pounds in the tank. The valves *C* and *H* may now be opened to such an extent as to permit a small quantity of gasoline and a comparatively large quantity of air to flow through the hose and the nozzle *A* may be directed to spray the parts which need cleaning. A single gallon of gasoline and a few strokes of the air pump have been found sufficient to clean thoroughly a single automobile.

Fig. 2, from the *Practical Engineer,* is another home-made device, a steam operated vaccum soot cleaner, made by an engineer correspondent and used for cleaning off the soot from the top of a battery of boilers, the work being done without raising a dust. The cleaner was made by connecting a ⅜-in. pipe from the steam line to a ¾-in. tee which connects as shown to a discharge pipe to the sewer, or other convenient place, and a steam hose upon which a funnel was attached. Use good stiff hose without kinks, and carry the funnel over the soot, which will be sucked into the hose and discharged into the sewer. It does not require much steam and will clean the boilers off thoroughly.

Fig. 3 is a sketch by A. Montgomery in the *American Machinest,* illustrating his method of hardening the shanks of tools used in the pneumatic hammer. It is necessary, he says, that the end of the shank of the tool, where it receives the blow of the hammer, should be hardened to a certain extent, so as to prevent upsetting and consequently enlarging; also to give it wearing qualities, and in order to obtain the best results the following is suggested: Take a pail and fill it about three-quarters full of salt water, covered with thin lard or fish oil to a depth not to exceed three-quarters of the entire length of the shank of the tool. Heat the shank a regular hardening heat and quench in this bath, being careful to keep the shoulder of the tool at the base of the shank, just on a level with the surface of the oil. Move the tool gently in this bath until entirely cold. Do not draw the temper, merely flash the oil from the tool. It will be readily seen that if the action is performed quickly by the operator, the tip of the shank will be hardened more than the body of the shank, as it reaches the water practically before any cooling takes place, and the actual hardening of the end will take place in the water beneath the oil. This gives a shank hardened absolutely right without any further heat treatment, such as drawing the temper, and rivet sets treated in this manner have been known to drive as high as 24,000 rivets before crystallization took place.

Fig. 4, from *Mines and Minerals,* illustrates a method of ventilating a mine by means of the water it makes, so that when once installed it costs nothing for operating. The method is said to be in common use in many camps, but to many it is unknown. A tunnel can be ventilated for 1,000 feet or more if ample water flows from it. As the water flows from the tunnel into the flume, it is carried out on to the dump until it reaches a point where it can have a fall of about 15 feet or more. Then it falls through a box made of four boards nailed together as nearly air-tight as possible. This box is connected to the inverted barrel as shown. The connection should be air-tight. The air pipe from the tunnel also connects with the barrel about in the middle of the side. This inverted barrel sets in a box which must be a few inches above the bottom of the barrel. The water as it flows from the bottom of the barrel rises over the box and flows away as indicated. The water flowing out in this manner and dropping some 15 to 20 feet causes a suction which will almost put out the flame of a candle in 1,000 feet through a 6-inch air pipe.

Fig. 5, from *Railway Age Gazette,* is a tandem pneumatic jack giving a double lifting power without increasing the cylinder diame-

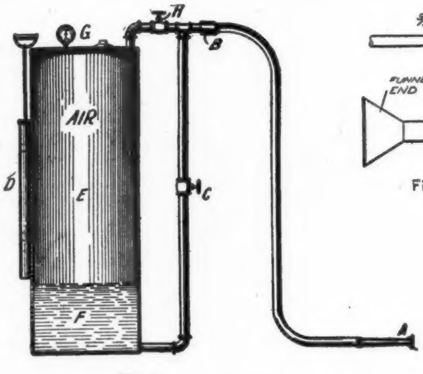


Fig. 1

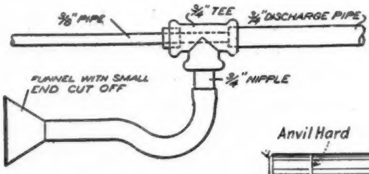


Fig. 2

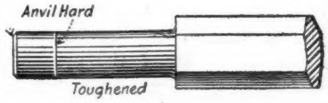


Fig 3

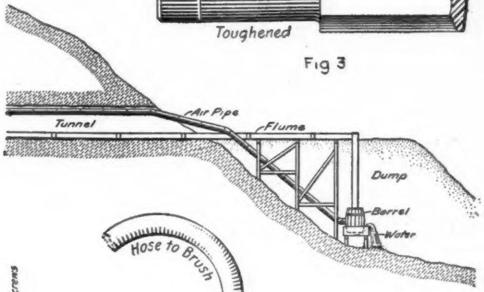


Fig. 4

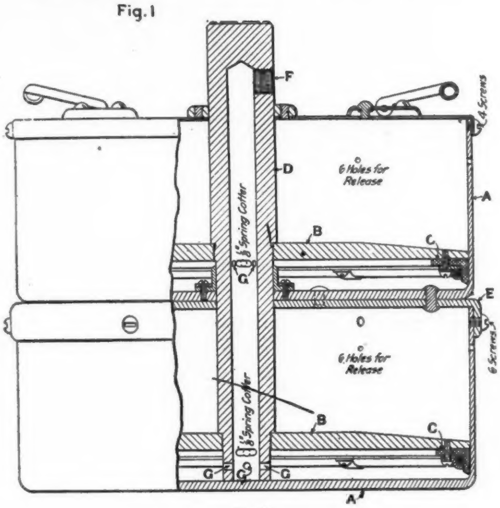
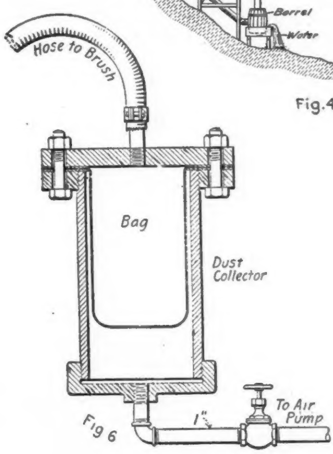


Fig. 5



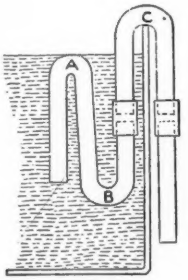
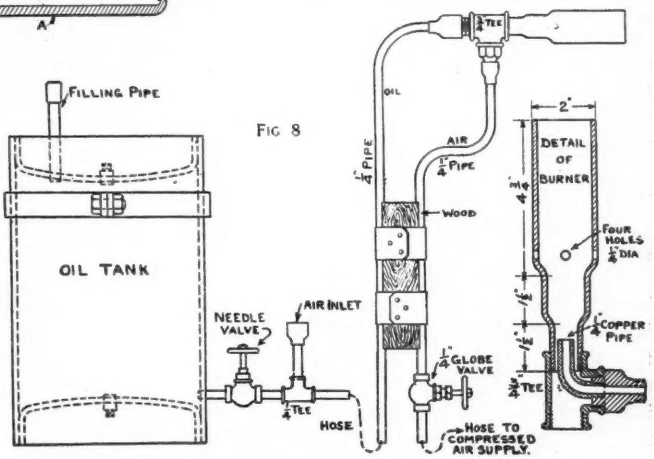


Fig. 7



VARIOUS PNEUMATIC DEVICES.

ter. The operation of the jack is self-evident and its design and construction are interesting. The parts *A* are pressed steel cylinders into which the boiler steel pistons *B* fit. The pistons are screwed to the same piston rod or plunger *D*, which is made of cold rolled steel shafting, and are locked to it by 1/8-in. spring cotter pins. The center of this rod has

a ¾-in. hole running part way through it. which conducts the air from the hose connection *F* to the underside of the pistons through the ports *G*. Leather washers *C*, of the Westinghouse standard, are fastened to each of the piston heads, and are forced against the sides of the cylinders by expansion rings, forming air tight joints. A cover *E* is placed over the lower cylinder and gives additional stiffness to both the walls of that cylinder and the base of the upper cylinder. The six holes shown near the top of each cylinder are for the purpose of releasing the air when the piston has traveled above them, thus preventing the rupturing of the cylinders. These jacks are made in 12-in. and 18-in. sizes by the Pneumatic Jack Company, Louisville, Ky.

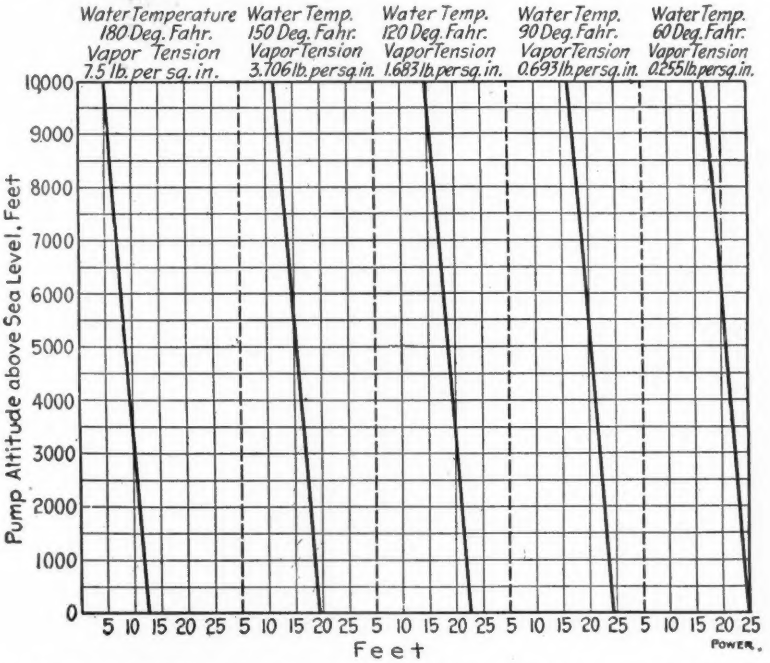
Fig. 6 is a vacuum cleaner described by J. G. Dennington in *Power*. It will be found useful in an engine room or elsewhere for sweeping the floor or cleaning the walls and is also especially effective in the cleaning of street car or steam-road coach seats. It can be used wherever there is a pump or a condenser. First, take a piece of pipe, preferably 12 inches in diameter, and cut it to the desired length (not less than 2 feet). Cover one end with a cap having a 1-inch pipe connection in it. Cover the opposite end as shown in the drawing. Make a bag out of good strong material like duck or canvas that will fit nicely inside the 12-inch pipe, not coming closer to the bottom than 6 or 8 inches. The top should be made flaring and will last longer if bound with a couple of sheet-iron rings the size of the flange. This sack is to catch the dirt and dust and is to be inserted inside the 12-inch pipe, and flaring top to be clamped between the halves of the flange union. To clean the bag, simply take it out and turn and brush it; it should go in either side out. The 12-inch vacuum chamber can be placed in any convenient location and connected to the suction side of the air pump or condenser with a 1-inch pipe, the connection being made in the bottom below the bag. For the top there should be a 1-inch hose connection, taken preferably from the center of the flange union, or a pipe may be run from the flange union around the plant to any desired location and taps taken from it at different points, when a shorter length of suction hose will answer for the cleaner. The cleaner may be made from hardwood, or a heavy brush may be used to advantage by cutting the bristles out of the center lengthwise of the brush, so as to form a slot about ½ to ¾ inch wide. The brush loosens the dirt and the air will draw it up into the hose. A slot will, of course, have to be cut through the wood of the brush and a holder for the hose may be made from a piece of pipe secured to the tin back with which it will be necessary to cover the brush.

Fig. 7, from *Popular Mechanics*, is a self-starting siphon which has proved useful in laboratory work in siphoning certain solutions, such as sulphuric acid or nitric acid when it would be dangerous to start the siphon by the usual method of suckig until the tube is full. If made of one piece of glass tube, so much the better, although it may be found easier to use two or three pieces connected with rubber. The ratio between the lengths of A-B and B-C must be about as four is to five. To begin with, the solution must be high enough to cover the first bend, then according to the law that a liquid always seeks its own level, one would suppose that it would enter the tube and settle at a point between B and C. However, the kinetic energy produced by the falling of the liquid from A to B is sufficient to force it up over the bend C. From there it simply falls and the siphon is in running action, having started automatically.

Fig. 8 is an oil burner, described in *Canadian Machinery*, and used in the G. T. R. shops at Toronto for a variety of purposes, such as the removal of locomotive tires, heating bent frames preparatory to re-straightening, heating boiler patches, etc. The whole apparatus is easily portable and of extremely simple construction. The oil tank, with capacity of about 5 gallons of crude oil, is filled through a funnel fitted with a strainer, so as to preclude the possibility of choking the needle valve which controls the supply to the burner. In front of the needle valve is a tee, into which is screwed a short length of pipe. At its end is a reducing coupling, forming a short cone, which serves to introduce atmospheric air to the oil pipe and is effective in causing a steady flow. Before this feature was adopted, it was found impossible to obtain a uniform and regular stream. The compressed air pipe terminates in a piece of bent

copper pipe, as shown in the separate detail of the burner. The issuing jet of air, creates a partial vacuum, and induces a flow of oil, which becomes vaporised as it enters the burner cone.

In taking off a tire, without removing the wheels from under the locomotive, the burner is packed-up on the rail, so that the flame strikes the tread of the tire at a small angle. The axle boxes are jacked-up, to bring the tire clear of the rail, and the wheel slowly revolved by bars to ensure the tire being uniformly heated all round. The time occupied averages about twenty minutes, depending to some extent, on the tire diameter.



SUCTION LIFT OF PUMPS AT DIFFERENT TEMPERATURES AND ALTITUDES

The diagram on this page, which seems to require no explanation, was sent to *Power* by Mr. W. Vincent Terry, Essex, England. For those who only cursorily glance at the diagram attention is called to the numbering of the feet on the bottom line, this not being continuous but repeated for each curve. The curves provide a ready and easy means of ascertaining the maximum suction lift that a pump is capable of dealing with at various altitudes and with different water temperatures. The curves, the writer says, are based on theory with suitable corrections from practice for mechanical efficiency"—what has that to do with it?—"leakage and air pressure, and have proved very useful to me in my work."

STORAGE PURIFIES WATER

The value of water storage as a means of improving its quality has been investigated for the Metropolitan (London) Water Board by its director of water examination, Dr. A. C. Houton. He carried on extensive experiments of the comparative vitality of uncultivated and cultivated typhoid facilli in artificially infected samples of water from the river, and reached the conclusion "that even a week's storage of raw river water is an enormous protection, and less than a month's storage an absolute protection against typhoid fever." He further asserts in his report that "the possibility of London water conveying epidemic disease may be finally dismissed from the minds of inhabitants of the metropolis as a fear which, on convincing experimental evidence to the contrary, has at last been definitely proved to be baseless."

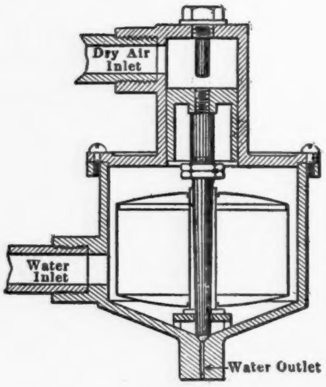


FIG. 1. EJECTOR VALVE FOR AIR LINE

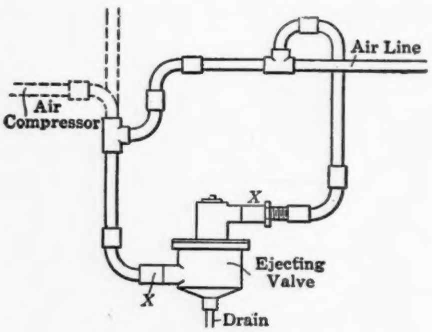


FIG. 2. PIPING FOR EJECTING VALVE

DRAINING THE AIR LINE

The cuts which we here reproduce from *Engineering and Mining Journal,* show an automatice device recently developed in England for removing the water which usually accumulates in compressed air pipe lines. Fig. 1 shows by vertical section the internal construction and Fig. 2 shows the mode of piping. It will be seen that the apparatus is not large. The case is a cylindrical casting of gun metal having, with its cover, three openings, two of which are threaded for pipe and the third is a small hole at the bottom normally closed by a small conical valve. This valve is the end of a gun metal spindle which carries a copper float, with a plunger above, the top of which is exposed to the pressure of the pipe line. This pressure is balanced by the air which may enter at the water inlet, the unsupported weight of the float being sufficient to keep the bottom drain-opening closed. When water enters the chamber from the water inlet the float is lifted, its travel being limited by an adjustable stop screw above, and the water outlet is opened. The pipe line pressure then blows all the water out and the float falls and closes the opening. When grit or other foreign substances are likely to get into the pipe line, strainers X are inserted at the points indicated in Fig. 2.

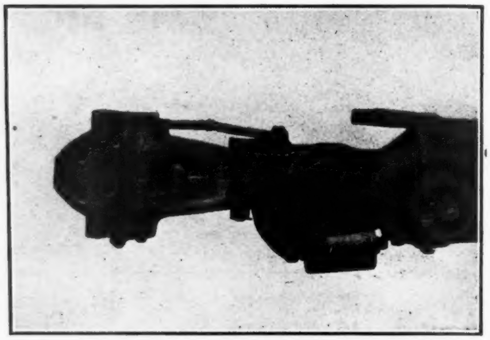
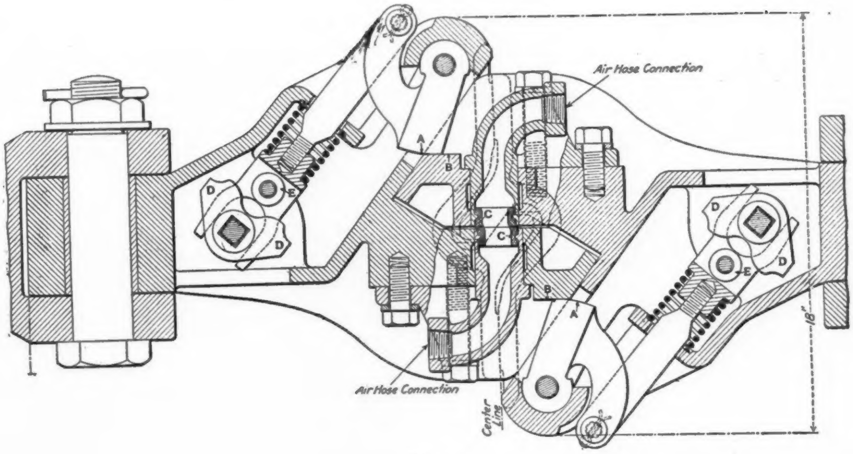


FIG. 1.

AUTOMATIC CAR AND PIPE COUPLER

The ingenious coupler shown in the half tone Fig. 1 and sectional drawing Fig. 2, has been designed by the Westinghouse Air Brake Company and is being largely adopted by the Interborough Rapid Transit Company, of New York. It automatically connects not only the drawbars but also the air connections of the two cars brought together. The coupler head consists of a solid body casting, which has a suitable hook and recess in its face to engage with the corresponding face of the other coupler. The heads are so designed that they will couple when 3 in. out of vertical alinement and 7 in. out of horizontal alinement. The couplers are held to the drawbar by a horizontal pin, which allows them to swing up or down, giving the necessary flexibility when passing over imperfections in the track. When uncoupled they are held in a horizontal plane by a spring located underneath the drawbar and pressing against the coupler.

The air connections run alongside of the drawbar and are connected to the coupler by a flexible hose, which is comparatively short in length and has no bends, thus eliminating any possibility of kinking. This hose is permanently connected and will wear for a



FG. 2.

longer time than the hose of the ordinary air connections. When coupled, the couplers are locked so that there is no lost motion between them. This is accomplished by the type of lock used, which, as will be seen in the sectional illustration, automatically takes up the play as the couplers become more closely interlocked. In coupling the two heads slide into each other for about $1\frac{1}{2}$ in. in a direction about 40 degs. with the axis of the drawbar.

The face of the locking cam *A* engages with the machined surface *B* of the opposite coupler. In case one locking cam should be out of service, it will be seen that the other is sufficient to hold the connection. It will also be noticed that the air connection gaskets *C* come together in almost a perpendicular line, which prevents undue wear from abrasion. The locking cam is controlled by a lever on top of the drawbar, which operates the cam *D* through segmental gears. This cam, working on the pin *E* throws the locking cam in and out of service as desired. Both of these locking cams must be thrown out before the cars can be separated and after being uncoupled they can be thrown into the coupling position again, allowing the couplers to lock automatically. When the couplers are locked together they are as rigid as a single casting, thus providing a tight joint for the air connections.—*Railway Age Gazette.*

The speed at which rock can be drilled does not indicate how it will break. It often happens that rock easily drilled is hard to blast.

PATCHING A SEA WALL WITH THE CEMENT GUN

The Massachusetts coast line in the vicinity of Lynn, is protected by a heavy concrete sea wall. The structure is continually wetted by the spray, and as there is a considerable rise and fall in the tides, the low portions of the wall are alternately above and below the water surface. These conditions, it is believed, have tended to cause the disintegration of the concrete face of the wall. Large holes have been formed and there are patches where the mortar surfacing has scaled off, exthis fact can be neutralized. The inventor of posing the large stones of the concrete aggregate. The reason advanced for the disintegration of the face is not that the salt water has any destructive effect upon the concrete, but that the water works into porous

sections in the wall and freezes, causing the face to peel off.

Attempts were made to patch up the holes by hand, using a Portland-cement mortar, but the results were not satisfactory, and when finished the patches stood out like large blotches on the surface, destroying the uniformity of the face of the wall.

A more efficient method of doing the work was sought, and Mr. John R. Rabin, chief engineer of the Metropolitan Park Commission, decided to try the "cement gun." This device consists essentially of superimposed steel tanks forming two compartments, from the bottom of which a dry mixture of sand and cement, which is entirely under the control of the operator, is ejected by compressed air through a hose line carrying a specially designed nozzle at its discharge end. To this nozzle a second and smaller hose delivers a supply of water under pressure. The mixture of sand, cement and water, the latter being supplied to the dry constituents just before they emerge from the nozzle, shoots out through the nozzle orifice with considerable force and impinges upon the surface at which the gun is pointed. The mortar issues in the form of a spray, which adheres to the surface, and may be built up to any thickness desired.

A cement gun machine was therefore shipped to Lynn and set up on top of the sea wall. The hose lines were carried down along the face of the wall and the nozzle was manipulated by an operator at the base, as shown in the accompanying illustration. Practically all of the patch work was near the foot of the wall, so that no scaffolding had to be erected. One of the advantages of the cement gun over the hand-patching method lay in the fact that all of the plant was located on top of the wall, so that nothing had to be moved when the tide came in. It was found also that the stream of mortar from the nozzle packed in tightly in all of the small crevices of a honeycombed section of wall, completely filling the gap. Before the patching work was actually started, however, all the loose pieces of concrete were picked away from the surface and an air blast from the cement gun nozzle turned upon the area to be repaired in order to blow away the dirt and dust, thereby securing a clean surface and making a good bond.

The mortar was mixed in the proportions of one part Portland cement to three parts sand. This resulted in an actual mixture, as applied to the wall, of about one to two, for when the blast is turned on a portion of the sand bounds away from the surface before the mortar starts to build up. Air pressure was furnished by a portable gasoline-driven compressor, and as an experiment 10 per cent. of hydrated lime was mixed in with some of the batches and about 2 per cent. of Toxement waterproofing compound in others.

After the patches had been made the entire wall was given a thin surfacing coat of mortar with the gun, and this resulted in making the entire face a uniform color and added greatly to its appearance. It was found that after the mortar had set from four to five hours it was sufficiently hard to resist the wave action—Condensed from *Engineering Record.*

THE RUPING PROCESS FOR CREOSOTING TIMBER

At a recent demonstration of this process, various shapes and kinds of wood were selected, such as redwood poles, timbers, sleepers, fencing, paving blocks, and whitewood battens and boards. These were all weighed and measured and then sealed up in a cylinder, where they were subjected to an air pressure of about 50 lb. per square inch, and then the cylinder was filled with creosote, the air-pressure being maintained. Next a pressure of 80 lb. per square inch was put on, after which the pressure was released and the cylinder opened. The timber was then taken out and re-weighed, showing the amount of oil remaining in it. Various pieces of the wood were cross-cut, and showed a remarkable penetration of oil, nearly to the centre. This, it was stated, was impossible in the old method except at a great cost, and this also applied to the whitewood, into which it used to be practically impossible to inject the oil. One of the features of the process is the extreme cleanliness of the treated wood. It is quite dry and clean to handle, and not dirty and clogged with oil as is generally the case with creosoted wood. By this method, it is stated, the cost is very greatly reduced, for waste of the preserving liquid is entirely avoided, whilst better results are obtained, it seems, than by the old method.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - Managing Editor
F. C. IGLEHART, Jr., - Business Manager
W. C. LAROS, - - Circulation Manager

PUBLISHED BY THE

Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XVI. DECEMBER, 1911. No. 12

CONTENTS

SKILL PROMOTERS

Mechanics in general are not wanting in respect for personal skill and the achievements of skill, but individually they still are quite apt each to assume that his own trade requires and develops more skill than any other. The machinist, the blacksmith and the molder, for instance, can each think that he can do and actually does things which for each of the others would be impossible. If it should come to be recognized and appreciated that each is probably correct in his view the fact should tend to promote mutual respect instead of the reciprocal depreciation which is most familiar.

It may be true in some things that "the looker-on sees the most of the game," but in watching the routine manipulations of workmen in the trades the looker-on cannot really be said to see the true inwardness of the game at all. The one operation of the molder's trade which has always taken more of his time and strength than any other has been the ramming of the sand in the molds. The unthinking on-looker can regard this as simply hard muscular labor and nothing more, and in that view of it the invention of the sand rammer was inevitable for the relief on the tired workman.

But to the well informed the operation of sand ramming in the foundry is one of great responsibility, and the success of the molder in the trade is never contingent upon the use alone of his muscle in ramming, but upon the judgment—skill's most potent factor—with which it is employed. There is, as the phrase is, ramming—and ramming, and skill is the differentiator. If the requirement were simply to pack the sand in the mold as tightly as possible the task of ramming would be a simple one and the power rammer might well be made automatic; but in fact it is usually most desirable and often very necessary to have the sand packed as loosely as possible, if it will only hold the molten metal to its shape, it thereby retaining some porosity to permit the escape of the gases generated or liberated when the mold is poured. It often happens also that some portions of the mold require to be rammed heavier or lighter than other portions and here the skill of the molder has a chance to show itself. Foundry experience is full of instances where the successful production of certain castings has been defeated by injudicious ramming and where later per-

fect results have been secured by a change in this detail alone.

The heading of this article suggests that the pneumatic hammer is a promoter of skill in the molder, and it should not be difficult to justify the title. The pneumatic hammer in the first place relieves the molder of the most fatiguing detail of his work and saves more of his energies for the thinking portion of it. This is not an imaginary benefit, for, other things being equal, the man strong in the arm and worked to the limit in that function is not also strong in the head, active in planning for the best results and quick to see the best ways leading to their attainment.

But in the act of ramming, the pneumatic hammer does much more than merely to supply the power for the work. It also changes the character of the ramming, and gives the molder a variety of execution in the ramming which his muscles at the best could not command. The force, the direction and especially the rapidity of the blows are so completely under the control of the molder that we might compare the manipulation of the hammer to the playing of a musical instrument, with its legato, staccato, crescendo, diminuendo passages, and all the rest of it.

THE HOISTING PROBLEM

There are no industries where the operation of hoisting and lowering of material, of tools and appurtenances, of work in progress or of the finished product, do not frequently and constantly occur, and other means than human muscle have to be provided; but we have been slow enough in getting at it.

The steam engine is well along into its second century, but we had only the hand-cranked crane and the rope and tackle blocks for all our heavy lifting up to the middle of the last century. Then the differential chain hoist came in. This, though still hand-operated, was a great improvement, in that it would hold the load; but it was slow in operation, both for hoisting and for lowering, and it required about as much power for the latter as for the former operation. The ingenuity of the device did much to give it a start and to continue its vogue so long.

The lifting of weights is one of the simplest operations for which mechanical power can be employed, and where men are still doing it the question is always pertinent as to why such waste of labor is permitted. The actual means by which the power is applied to the specific job must be determined by the conditions. For the simplest lifts we have at once the simplest device which can probably be devised. The direct air hoist is quite common now, but its general employment began only about a score of years ago, and there are still many places where it is conspicuous by its absence. Many industrial concerns even up to the present day have failed to provide for themselves an air supply, and for these, of course, there is an explanation, but not an excuse or justification; but where the air is there should be the air hoist. Quite recently the writer noted the anomaly of a stone yard with pneumatic tools at work but with only hand-operated hoists.

Though the direct air hoist is so simple in its action, responding with ideal promptness to the manipulation of its valve for either motion, still its very simplicity and promptness sometimes seem to be in excess. It may hoist too quickly and may not stop the load at the precise point desired, while a careless hand may drop the load too sharply. It also, when the air is shut off, will not hold its load continuously, slight leakage allowing a slow descent—extremely slow, if everything is all right—but still it cannot hold absolutely. The motor hoist has more than all of the desirable properties and none of the objections here suggested. It is entirely responsive to the control of its manipulator. It will hoist at any speed desired; it will stop with precision; it will hold its load absolutely for any length of time; it will lower gently and will not run down to make unnecessary slack to be taken up before the next hoist. It is useful for running along overhead tracks and holding the load suspended from place to place. The desirable features seem to be all there, with nothing to offset them.

The electric air drill made it possible to run an entire mining, tunneling or quarrying plant entirely by electricity and to dispense with the air compressor. The air motor hoist does the reverse of this and makes it just as possible to dispense with the electric current when it is not otherwise imperatively needed and to use only the air. The desirability of using in either case the single style of power trans-

mission is sufficiently apparent. The type of motor which actuates the air-motor hoist can be used, and is used, for driving rotating drills for metal, and for other tools in machine shops, boiler shops and elsewhere. Like all other air-operated devices, the motor hoist costs nothing for power or for power maintenance except when it is actually working. The moment the dynamo stops the electric motor is paralyzed, but there is always air enough for a hoist in the receiver.

QUESTIONS AND ANSWERS

I. S. G. How far would the piston travel in an air compressor cylinder to raise the pressure of the cylinder of air from atmosphere to 1 lb. gage? Also supposing the contents of the air cylinder to be 1 lb. above atmosphere at the beginning of the stroke, how much greater would be the quantity of air in the cylinder as compared with a cylinderful at just atmospheric pressure? A. For the first question, neglecting the change of temperature and assuming the cylinder to be just filled with air at atmospheric pressure at the beginning of the stroke, the difference in the air volume before and after the compression would be inversely as the absolute pressure, thus:

$$147+1:14.7::1:.936$$

and the piston travel would therefore be: $1-.936=.064$, or say just a trifle over 1-16 of the stroke. Again, as the cylinderful of free air when compressed to 1 lb. above atmosphere occupied only .936 of the cylinder the cylinderful at 1 lb. pressure would be $1\div.936=1.068$.

C. S. D. Will you kindly give us the solution to the following: The diameter of the piston is 1—9-16", the stroke of the piston is ⅜" and the number of revolutions per minute is 3500. How many cubic feet of free air would be required at a pressure of 135 pounds? What capacity of air compressor would be required to maintain this pressure of 135 pounds?

A.— We offer the following rough solution, as the case does not warrant the going into questions of temperature, etc. In fact we think the figures we give are the best to use for such small practice. We understand that you want to drive an engine or motor with compressed air and you wish to know the volume of free air required. Assuming that the engine is double acting and that there is no cut off, the computation for the air consumed would be:

$$1.5625 \text{ (cyl. dia)} \times .7854 \times .75 \text{ in. (for double stroke)} \times 3500 \text{ (revs. per min.)} \div 1728 = 2.91 \text{ cu. ft. per min.}$$

This is very nearly 3 cubic feet, and adding one-third for clearance and other losses, we have 4 cubic feet of air at 135 lbs., gage pressure, or $135 + 15 = 150$ lbs. absolute pressure, or ten atmospheres. Then the volume of free air will be: 15:150::4:40 cu. ft. of free air per minute. A common commercial size for a small compressor, usually power driven, would be 6 in. diameter by 6 in. stroke. This, either double acting or with two single acting cylinders, at 250 revs. per min., would have a theoretical capacity as follows:

$$6^2 \times .7854 \times 1 \text{ ft. (for double stroke)} \times 250 \div 144 = 49 \text{ cu. ft. per min.}$$

Such a compressor could not be run continuously up to such a pressure on account of the heat developed, and it should not be so run on account of the greater power requirement as compared with two-stage compression, but it would do for short, intermittent runs.

NEW BOOK

Rock Drilling with particular reference to Open Cut Excavation and Submarine Rock Removal, By Richard T. Dana and W. L. Saunders. Data compiled by Construction Service Company, New York, John Wiley & Sons, 327 pages, 6 x 9 inches, 127 illustrations, mostly half tones, $4.00 (net).

The book is fairly described by its title-pages. It is a compilation of practical data from reliable sources. It tells of work actually done and of the means and methods employed. Blasting and Explosives are first discussed, then the Rock Drill in all its relations, while the bulk of the work is made up of records from actual operations, first in open work on land and then in subaqueous drilling and excavation.

The volume of the lithosphere, or stony crust of the earth, including the continents elevated above the sea, is estimated at 1,633,000,000 cubic miles.

OZONE IN THE INDUSTRIES

In an article which recently appeared in the *Times,* of London, it is stated that experimental trials have been carried out, both in England and elsewhere, relating to the use of ozonized air in the various operations carried on in breweries, and these indicate that ozone could be used with advantage either in the treatment and cleansing of brewing vessels and casks or in the ventilation of the vessels and tuns in which the wort is stored. The presence of large numbers of bacterial and other living organisms in the air of towns has a prejudicial influence upon the fermentation of the wort, and in some cases the troubles that arise in brewing are attributed to the action of these agents. By means of ozonizing apparatus sterilized air could be supplied to the refrigerating and storage vessels containing the wort, and the dangers of contamination be avoided. Another advantage of the applications would be that the mould fungi and other micro-organisms, which are usually found upon the walls of the vessels and rooms, would be killed and their further growth stopped. The use of ozone for bleaching flour has also been the subject of many experiments, and has also led to considerable patent litigation. This application of ozone, however, has not developed, and it is now generally considered that pure ozone will not bleach flour, and that it was probably the presence of nitrogen oxides or of hydrogen peroxide which yielded the results, which were claimed to be due to ozone in the earlier experiments.

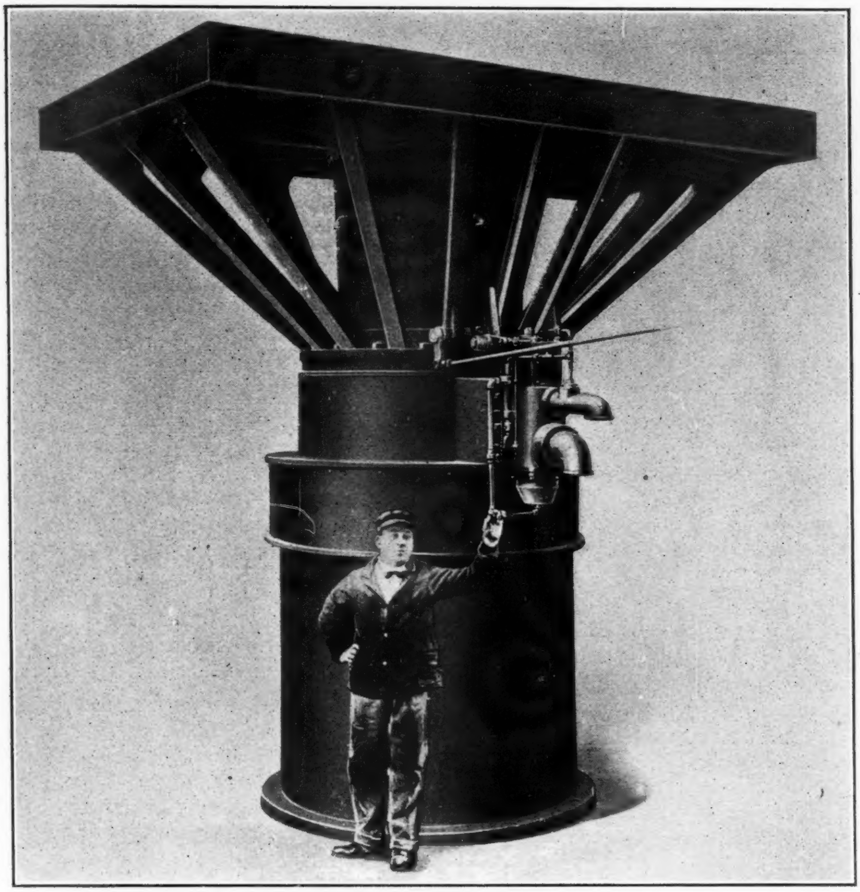
IMPROVED AIR SERVICE FOR A CRUCIBLE FURNACE

An oil-fired, tilting crucible furnace, recently patented in Germany by W. Buess, makes provision for cooling the bottom of the furnace and heating the air at the same time. The furnace consists of the usual, cylindrical chamber lined with fire brick and is provided with hollow trunnions supported in bearings in a standard to permit of tilting the furnace. The furnace is equipped with a detachable base formed of a slab of refractory material supported by a cellular metal bottom provided with flanged edges to enable it to be bolted onto a corresponding flange on the bottom of the furnace casing. The air is conveyed by means of the trunnion to the hollow bottom where it circulates in such a manner as to cool the bottom and at the same time absorb the maximum amount of heat. From the chamber the heated air passes to the burner through a valve controlled pipe. By this arrangement the compressed air, which serves to inject the liquid fuel, not only serves to cool the hottest part of the furnace, but is simultaneously warmed prior to its mixture with the oil, resulting, it is claimed, in a considerable saving in repairs and fuel.—*The Foundry.*

THE LARGEST SHOCKLESS JARRING MOLDING MACHINE

The shockless jarring machine, for packing the sand in foundry molds to the required density without the tedious operation of ramming, was described and its principle of operation explained in COMPRESSED AIR MAGAZINE, July, 1910, page 5710.

In its usual form the machine consists of a jarring table—this the top of the machine upon which the mold to be jarred is placed—the table mounted upon an upstanding plunger forming the anvil, which in turn is mounted in a cylindrical base and supported upon long helical springs. Compressed air is admitted through an automatic valve, under hand control, attached to the plunger or anvil base, and passes first into the jarring cylinder to raise the loaded table, At some predetermined point in the table movement, the air is automatically cut off from the cylinder, and while the valve is reversing, the air will expand and lift the table further from its anvil, provided its initial pressure exceeds the balancing pressure due to the weight carried. Then, when the operating valve completes its reverse movement the air from the jaring cylinder may be exhausted into the atmosphere, but preferably it passes from the jarring cylinder to the anvil cylinder beneath, and the table drops by gravity against the reduced pressure in the cylinder. At the same time the plunger base or anvil is relieved of a considerable part of the load carried by its supporting springs, which immediately expand, giving the anvil an upward velocity to meet the falling table. When air is expanded from the jarring cylinder into the anvil cylinder this upward velocity of the anvil is augmented and the falling velocity of the table is



LARGEST SHOCKLESS JARRING MOLDING MACHINE.

somewhat retarded, but in any case the momentum of the rising anvil is substantially equal to that of the falling table at the instant of impact. As a result, both table and anvil come to rest with great jarring or ramming effect upon the sand, but without shock or jar upon the foundation or any surrounding material.

These machines have been built in various sizes and operated with complete success, perhaps the most satisfactory practical endorsement being in the possibility of such a machine as shown in the halftone, believed to be the largest jar-ramming molding machine ever built and being actually the largest of the shockless type yet manufactured. This machine was built by the Tabor Mfg. Co., Philadelphia, and is equipped with a steel table, 8 x 12 feet, with cylinder attached, 36 inches in diameter. It is mounted upon a plunger base of cast iron, weighing about 65,000 pounds. The plunger base is fitted in the cylinder base, five feet in diameter and rests upon 22 helical steel springs, aggregating over 3,000 pounds in weight. The total weight of the machine, as shown, is between 90,000 and 100,000 pounds. The machine has already been tested and will soon be shipped to a large iron foundry in the vicinity of Philadelphia. The tests have shown that the action and control is equal to that of any of the smaller machines of the same type, and the company for which it has been built expects to ram molds with this device from six to eight feet wide and 12 to 18 feet long, weighing anywhere within the rated capacity of 50,000 pounds.

NOTES

A subsidiary company of the Canadian Northern Railway has completed plans for effecting an entrance into the heart of the city of Montreal by building a three-mile tunnel under Mount Royal. A new terminal will also be constructed, in which the latest improvements in terminal facilities will be embodied. The total cost of the tunnel and terminal together will be $25,000.000.

Calculation shows that a thistle-down starting from an elevation of 20 feet, in still air, would require two-thirds of a minute to reach the ground. With a wind blowing 20 miles an hour it would be carried, on the average, about a fifth of a mile. The total surface exposed to the air in an average thistle-down is, on account of the great number of hairlets, a little more than one-third of a square foot.

Natural gas can be liquefied by pressure, either alone or with the aid of refrigeration in a manner similar to that employed in the manufacture of "blau gas," which is liquefied under a pressure of 15000 lb. per square inch and is shipped in steel drums to wherever it is needed. On releasing the pressure the liquid becomes a gas again and can be employed for any purpose for which gas is used.

The reason that explosions in bituminous mines are more apt to occur in late fall and winter than any other season, is because the mines are drier in winter. Cool air contains less moisture than warm air, the warmth of the mine raises the temperature of the entering, cold, winter air, and as the air becomes warm, it absorbes water, thus taking up the moisture and depositing it outside.

When it is desired to secure an approximate idea of the movement or velocity of an air current that appears almost stagnant, and if an anemometer is unavailable for immediate use, a heavy rag, or a piece of brattice cloth charged with dust will prove a ready means of making the test. A rap of the hand on the rag or cloth will raise a cloud of dust which the air current will carry away, allowing the observer to form an estimate of the velocity.

A great dam is being built in the Mississippi River, between Illinois and Iowa, at Dallas City, Ill., which will cost $27,000,000 and develop about 200,000 horsepower. It is expected that the cheap power thus made available will develop a great manufacturing city.

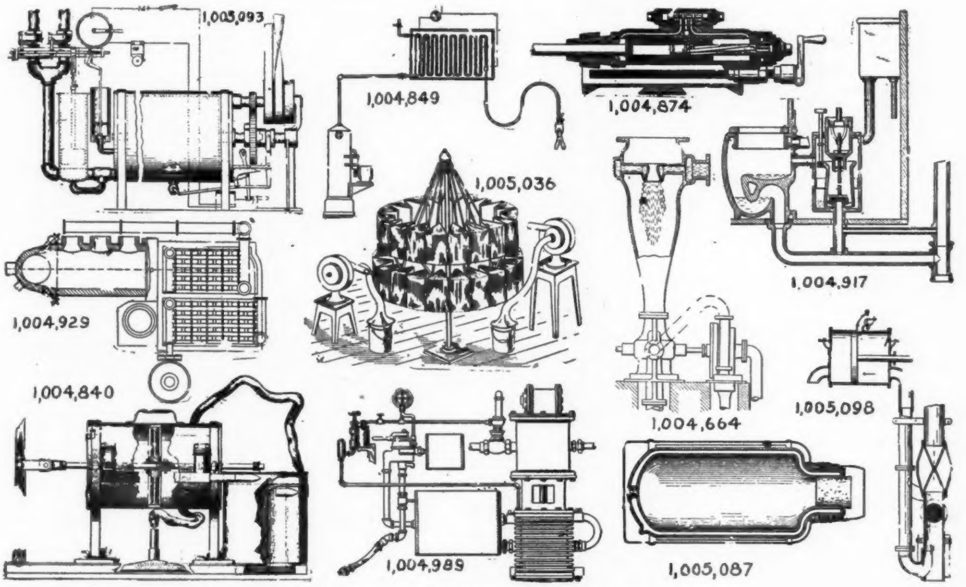
The number of men employed in the word's mines and quarries exceeded 6,000,000 for the year 1909, according to a recent report of the British chief inspector of mines. The total number was probably nearer 8,000,000; since the English figures include for the United States only our coal miners, and but part of our metal miners. A few countries comprising Bolivia with its tin mines, Brazil with its gem fields, China with its coal, iron and tin mines, Turkey and Persia are unrepresented in the statistics.

It is stated that Messrs. Krupp, of Essen, are now producing a type of steel for safes which resist the action of quick-cutting drills and breaks the best bits like glass, and it is equally proof against the blowpipe. To cut it in this way a length of time is required not at the disposal of a burglar. To cut a plate 1½ in. thick with a blowpipe, it takes 6 to 14 hours, 420 cu. ft. of hydrogen and 450 cu. ft. of acetylene. This would involve the conveying of six steel cylinders of compressed gas, each weighing 150 pounds, which is presumably beyond the resources of the average burglar.

At a recent meeting of the Lancashire section of the British Assocation of Managers of Textile Works, Mr. F. W. Parks, of Fitchburg, Mass., in a paper on the development of pneumatic service for textile mills, described the wide use that was being made in the United States cotton mills of compressed air cleaning plant. By the aid of a pneumatic service, he staid, there was an enormous saving of time and money, while the cleaning of the mill machinery was more efficiently done. He predicted that in a few years a pneumatic service would be installed in all our textile mills if pace was to be kept with the onward

march of modern improvement. In the course of a brief discussion the view was expressed that in England, at all events, vacuum suction would be a more effective agent in the cleaning of mill machinery than compressed air, which drove dust and lint merely from one place to another. It was agreed that in some departments of work compressed air would be valuable.

An international machinery and engineering exhibition will be held at Olympia, London, from October 4 to 26, 1912, inclusive. This exhibition is organized by the Machine, Tool and Engineering Association, Ltd., and the exhibition offices are at 104 High Holborn, London, W. C. The projectors of the exhibition state that it is their purpose to secure, if possible, so comprehensive a display that it will be really representative of the engineering trades throughout the world. Copies of the prespectus, etc., will be furnished to those addressing the Bureau of Manufactures, Washington, D. C.



PNEUMATIC PATENTS, OCTOBER 3.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 3.

1,004,573. CRUDE-OIL BURNER. WILLIAM B. JOHNSTON, Clinton, Okla.

1,004,629. APPARATUS FOR CONTROLLING THE FLOW OF LIQUIDS OR GASES. SAMUEL COOK, Wilmerding, Pa.

1,004,664. CONDENSER. MAURICE LEBLANC, Paris, France.

4. The combination with a centrifugal device adapted to separate air from water and to discharge the water, of a condensing chamber connected to the inlet of said device and constructed so that air passing therethrough is compressed, and an air pump connected to said device so as to remove the air therefrom.

1,004,840. VACUUM-CLEANER. WILLIAM J. ACKLEY, Batavia, N. Y.

1,004,849. TONSORIAL APPARATUS. WILLIAM J. CITRON, San Francisco, Cal.

1. A tonsorial apparatus, comprising a tank adapted to contain fluid under pressure, a massaging implement, tubular connection between the tank and implement, said connections including a tube bent into coils to form a tortuous passage for the fluid, valves controlling the flow of fluid through the coils, and means for heating the coils during the passage of fluid therethrough.

1,004,874. POWER-OPERATED PERCUSSIVE TOOL. CHARLES H. HAESELER, Philadelphia, Pa.

1,004,906. AIR-PUMP. JOHN ROBERTSON, Cincinnati, Ohio.

1,004,917. VENTILATING APPARATUS FOR CLOSET-FIXTURES. CHARLES E. SHADALL, Milwaukee, Wis.

1,004,929. APPARATUS FOR THE MANUFACTURE OF STEEL. GUY JAMES STOCK, Darlington, England.

1,004,989. LUBRICATOR FOR AIR-PUMPS. MARTIN CARLE and WILLIAM E. KRAFT, Clifton Forge, Va.

1,005,005. VACUUM-CLEANER. CHARLES A. DILLON, Canton, Ohio.

1,005,036. METHOD OF DISINFECTING BOOKS. THOMAS H. HOOD, Greenville, Miss.

1,005,087. VACUUM-INSULATED BOTTLE. GARRY P. VAN WYE, New York, N. Y.

1,005,093. AUTOMATIC CONTROLLING

MEANS FOR WASHING-MACHINES. GEORGE WILSON, Boston, Mass.

1,005,098. PNEUMATIC CONVEYING APPARATUS. PHILIPPE VAN BERENDONCK, Brussels, Belgium.

OCTOBER 10.

1,005,196. MINE SAFETY APPARATUS. MATUREN GOLD, Hayward, Okla., and WILLIAM ARTHUR MONTGOMERY, Solano, N. Mex.

1. The combination of a mine, a system of pipes therein provided with a series of valved taps, means for forcing air through said pipes, and a helmet provided with an air vent and with a plurality of flexible air inlet pipes having couplings connectible with said taps.

1,005,201. PNEUMATIC CUSHION FOR VEHICLES. CALEB STEVENS GURNEY, Portsmouth, N. H.

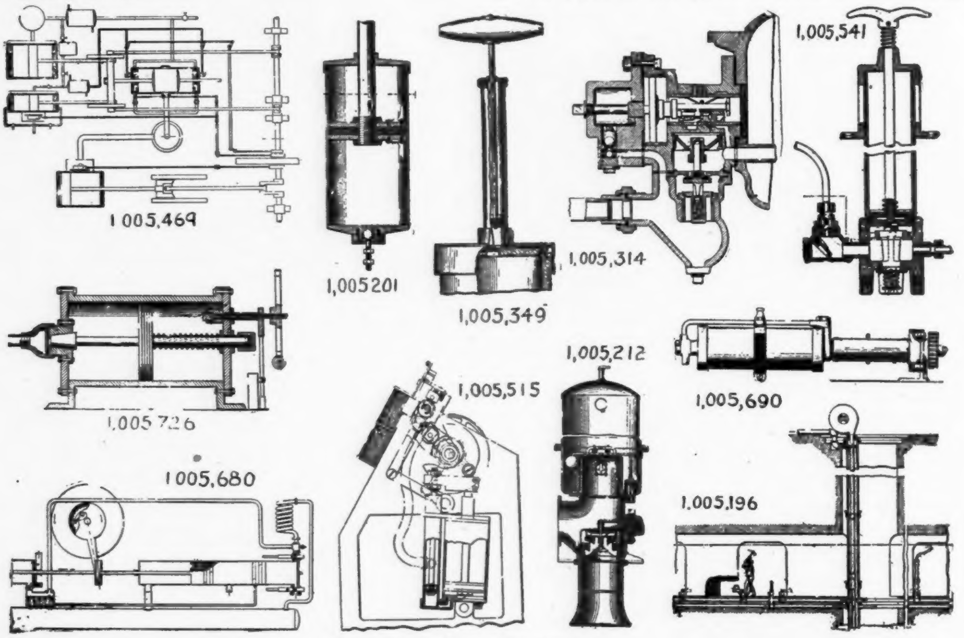
high-pressure exhaust open to the low-pressure cylinder for a variable part of the cycle to scavenge and charge the high-pressure cylinder, and means for admitting fuel to the latter during a period inversely related to the duration of exhaust opening.

1,005,515. VACUUM-PUMP. HENRY B. COOLEY, New Britain, Conn.

1,005,541. ENGINE-STARTING APPARATUS. EDWARD A. HALBLEIB, Rochester, N. Y.

1,005,680. EXPLOSION CYCLE AND MOTOR OF ATMOSPHERIC TYPE. JULES ALFRED BABIN, Versailles, France.

1. An internal combustion engine, comprising in combination, an explosion cylinder having a piston, a pump cylinder also having a piston, said pistons being coupled together, an air-tank containing air under pressure, and having an open communication with said explosion cylinder in front of the piston therein, a charge coil,



PNEUMATIC PATENTS, OCTOBER 10.

1,005,212. AIR-COMPRESSOR. STIRLING B. HILL, CLIMIE E. HILL, and WILLIAM R. HILL, Seattle, Wash.

1,005,290. COMPRESSED - AIR CARPET-CLEANER. EDWIN E. OVERHOLT, Washington, D. C.

1,005,314. TRIPLE VALVE FOR FLUID-PRESSUE BRAKES. JOHN W. ROBINSON, Yoakum, and FRANK L. DOUGLAS, Rockport, Tex.

1,005,349. VACUUM-PACKAGE APPARATUS. GRAY STAUNTON, Evanston, Ill.

1. The combination with a receptacle having a single opening, and an imperforate closure therefor, of an exhaust pump, and a valveless cap terminal secured to said pump, inclosing the receptacle closure and adapted to make air tight contact with the receptacle beyond said closure.

1,005,469. STAGE-COMPRESSION INTERNAL-COMBUSTION ENGINE. SIDNEY A. REEVE, Worcester, Mass.

1. The combination of a two-stroke cycle explosion motor having serially-related high-pressure explosion and low-pressure expansion cylinders and their pistons, external means for charging said high-pressure cylinder with air and fuel under pressure, means for holding the

means openly connecting said coil and said air-tank, a conduit connecting said pump cylinder and said coil, a valve connection between said coil and said explosion cylinder behind said piston therein, and a valved outlet from said explosion cylinder.

1,005,690. AUTOMOBILE TIRE-PUMP. FRANK E. CARLSON, Chicago, Ill.

1,005,726. TRAIN EMERGENCY-STOP. WINFIELD L. MATCHETT, Harrisburg, Pa.

OCTOBER 17.

1,005,816. PORTABLE BREATHING APPARATUS. ALEXANDER BERNHARD DRAGER, Lubeck, Germany.

1,005,878. EXPANSION-ENGINE. GEORGE H. REYNOLDS, Mansfield Depot, Conn.

1,005,911. HYDRAULIC-POWER AIR-COMPRESSOR. FRANCIS P. WILBUR, Milwaukee, Wis.

1,005,923. VALVE-GEAR FOR FLUID-PRESSURE ENGINES. HENRY W. AYLWARD, New York, N. Y.

1,005,940. AIR-COMPRESSOR. CHARLES JEROME COSTELLO and STEPHEN GUION SKINNER, Chicago, Ill.

1,006,034. BLOW-TORCH. JACOB WEINTZ, Cleveland, Ohio.

1,006,063. DEVICE FOR CRANKING AUTOMOBILES. JOHN S. CLARKE, East Cleveland, Ohio.

1. In a road machine having an engine shaft, a rotary device adapted to be operatively connected with one end of said shaft, an air storage tank and a plurality of air passages open from said tank into said rotary device, valves controlling the passage of air in said passages respectively, a hand lever and mechanism therefrom adapted to open and close said valves and an air passage between said passages leading to the connection between the said rotary device and said shaft and a piston in said latter passage adapted to close said connection with the shaft.

1,006,100. DIFFERENTIAL-PRESSURE GAGE. WALTER GEORGE KENT and JOHN LAWRENCE HODGSON, London, England.

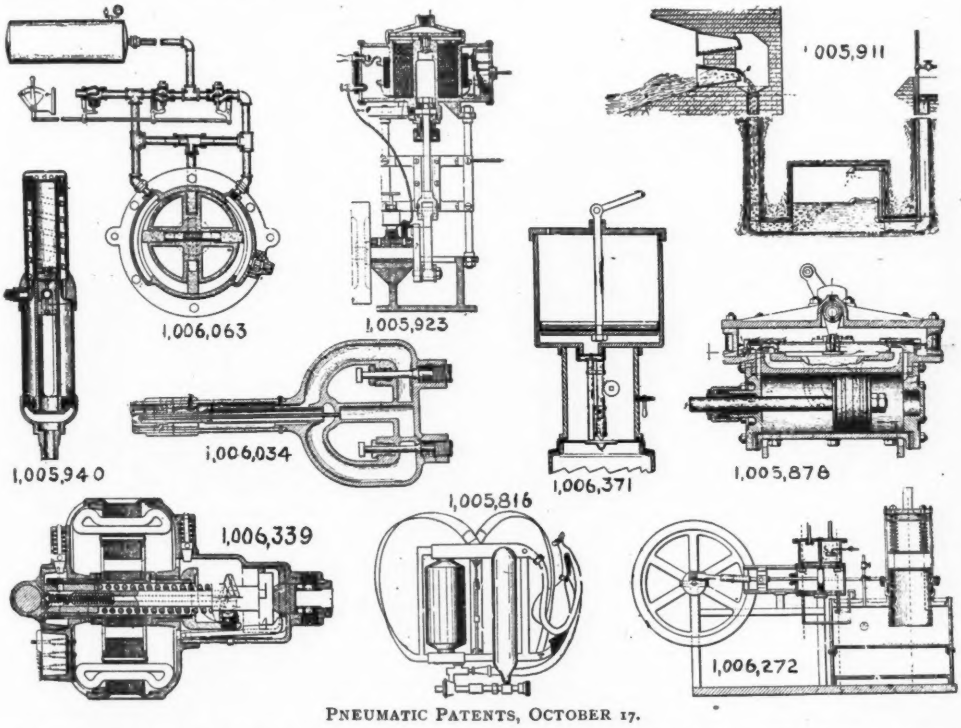
and vertically movable therein; a socket adapted to hold a plug for the can and loosely supported on the end of the rod and axially movable thereon; a spring connecting said rod and said socket to keep the socket near the end of the rod; and a toothed rack and wheel adapted to be operated from outside of said chamber and engaging said rod to move it vertically whereby the socket is moved to carry the plug to the can and whereby the rod continues its motion and frees the plug from the socket.

OCTOBER 24.

1,006,497-8-9. AUTOMATIC AIR-BRAKE. WILLIAM A. PENDRY, Detroit, Mich.

1,006,540. INTERNAL-COMBUSTION PUMPING-ENGINE. CHARLES EMMONS, Everett, Wash.

1,006,577. AIR PURIFIER, MOISTENER, AND HEATER. WILLIAM F. MCGUIRE, Rockford, Ill.



PNEUMATIC PATENTS, OCTOBER 17.

1,006,249. PNEUMATIC SEPARATOR. ERNEST D. MAXWELL, Clifton Forge, Va.

1,006,272. POWER APPARATUS. JOSEPH PREATKA, San Francisco, Cal.

1. In a power plant, the combination of a fluid pressure reciprocating engine, a drive shaft rotatable thereby, a piston reciprocated through said drive shaft, means by which the exhaust fluids from said engine will be compressed in a tank, means by which hot products of combustion mingled with air will be delivered by said piston under pressures into said tank, and heating means for expanding the fluids in said tank, the compressed fluids in said tank forming a reserve pressure.

1,006,339. ROCK-DRILL. THOMAS EDGAR ADAMS, Cleveland, Ohio.

1,006,371. CANNING APPARATUS. JAMES DUNN, Tacoma, Wash.

A canning apparatus comprising an air pump adapted to exhaust air from a can; a chamber connected thereto; a rod within said chamber

1,006,640. INSULATED AIR-PIPE. ARTHUR FAGET, San Francisco, Cal.

1,006,809. CARBURETER FOR INTERNAL-COMBUSTION ENGINES. JULIUS M. ULRICH and WILLIAM RAHR, Jr., Manitowoc, Wis.

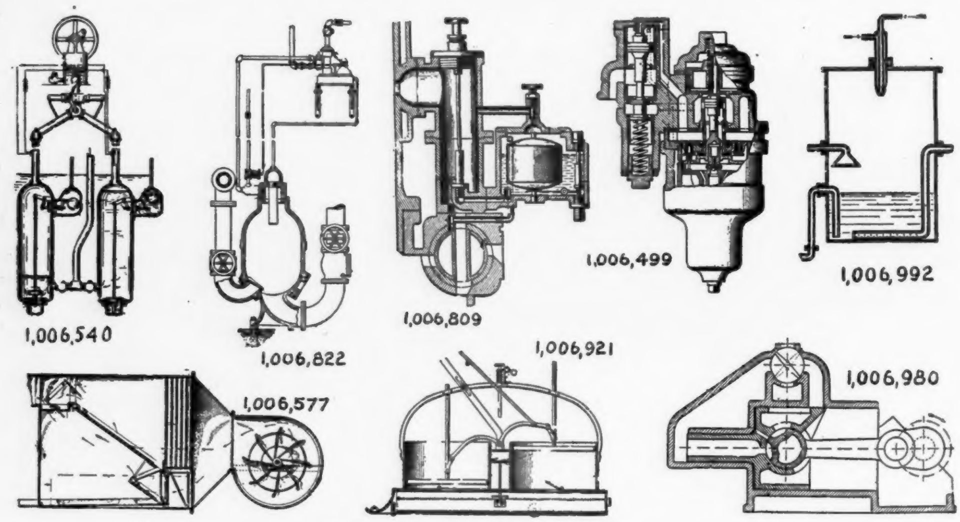
1,006,822. APPARATUS FOR EJECTING FLUID MATTER. HUBERT BEDDOES, Philadelphia, Pa.

1,006,883. ENGINE FOR PORTABLE PNEUMATIC REVERSIBLE DRILLING - MACHINES. CHARLES SCHOFIELD, Newcastle-upon-Tyne, England.

1,006,912. COMPRESSED-AIR SYSTEM. WILLIAM S. COOK, Atlantic City, Wyo.

1,006,921. PNEUMATIC OR VACUUM CLEANER. THOMAS B. DOWNEY, Springtown, Ark.

1,006,980. FLUID-PRESSURE ENGINE, PUMP, EXHAUSTER, OR COMPRESSOR. WILLIAM REAVELL and EDWIN WALTER JONES, Ipswich, England.



PNDUMATIC PATENTS, OCTOBER 14.

1,006,992. PROCESS FOR STERILIZING MILK AND MILK PRODUCTS. EMIL WIENER, Vienna, Austria-Hungary.

1. The process for sterilizing milk and cream by ozone, which consists in exposing the liquid to the ozonized air in an atomized form and then subjecting the same to an aerating process and removing the ozonizing taste and simultaneously preventing any particles of the ozonized air from remaining in the liquid.

OCTOBER 31.

1,007,046. PROCESS OF PRESERVING MILK. JOSE M. AGUAYO, Artamisa, Cuba.

The process of preserving milk consisting in excluding the same from the atmosphere, subjecting the milk, while so excluded, to the action of oxygen gas at a pressure of from five to six atmospheres, maintaining the milk under the action of the oxygen gas at such pressure for a suitable period of time, then reducing the gas pressure, and thereafter continuously subjecting the milk to the action of the oxygen gas under the reduced pressure.

1,007,095. HYDRAULIC AIR-COMPRESSOR. ALFRED O. GIRARD, Milwaukee, Wis.

1,007,105. AIR-BRAKE. NORMAN A. HILL, Baltimore, Md.

1,007,145. ESCAPE DEVICE FOR SUBMARINE BOATS. JOHN SCHNITTER, Baltimore, Md.

1,007,249. ELASTIC-FLUID TURBINE. WILLIAM E. SNOW, Hyde Park, Mass.

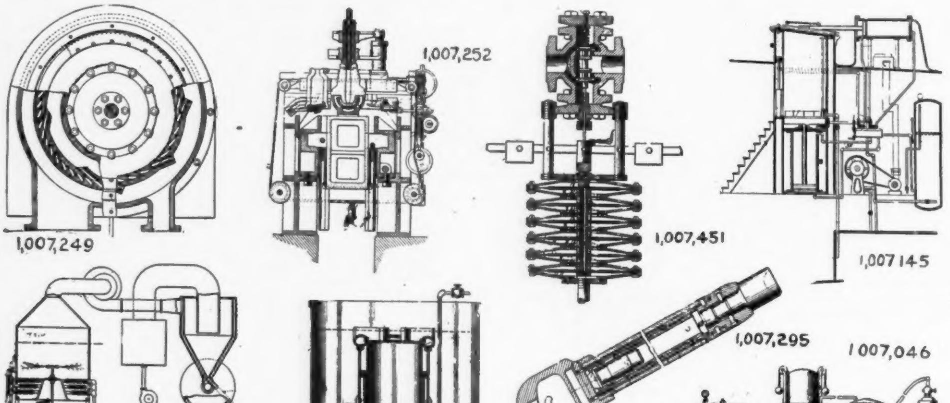
1,007,252. MANUFACTURE OF GLASS ARTICLES. CHARLES C. STUTZ, Norwood, Ohio.

1,007,295. PNEUMATIC HAMMER. VICTOR EDWARD LANE, Berwick, Pa.

1,007,381-2. APPARATUS FOR DESICCATING AND COLLECTING SOLIDS FROM FLUID SUBSTANCES. WILLIAM S. OSBORNE, New York, N. Y.

1,007,451. FLUID-PRESSURE REGULATOR. WILLARD A. KITTS, Jr., Oswego, N. Y.

1,007,599. METHOD OF DESICCATING LIQUID SUBSTANCES. WILLIAM SILAS OSBORNE, New York, N. Y.



PNEUMATIC PATENTS, OCTOBER 31.

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Stearns-Roger Mfg. Co.
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Jos. Dixon Crucible Co.

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Galigher Machinery Co.

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Cooper Co., C. & G.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.

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Westinghouse Air Brake Co.

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Jewett.

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Sullivan Machinery Co.

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Baldwin Locomotive Works.
Porter Co., H. K.

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Sullivan Machinery Co.

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Clark Co., W. J.
Galigher Machinery Co.

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Chicago Pneum. Tool Co.
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Galigher Machinery Co.
Gardner Compressor Mfg. Co.
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Ingersoll-Rand Co.
[illegible]-Martin Pump Co.
McKiernan-Terry Drill Co.
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Pangborn Co., Thomas W.
Powell Co., Wm.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.
Westinghouse Air Brake Co.

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Galigher Machinery Co.
Gardner Compressor Mfg. Co.
Mason Regulator Co.
Powell Co., Wm.
Republic Rubber Co.

Compressor Regulators.
Chicago Pneum. Tool Co.
Gardner Compressor Mfg. Co.
Mason Regulator Co.

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Sullivan Machinery Co.

Core Drills, Diamondless.
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Pangborn Co., Thomas W.

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Cooper Co., C. & G.
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Jos. Dixon Crucible Co.

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Jos. Dixon Crucible Co.

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Galigher Machinery Co.
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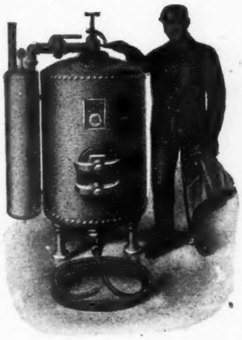

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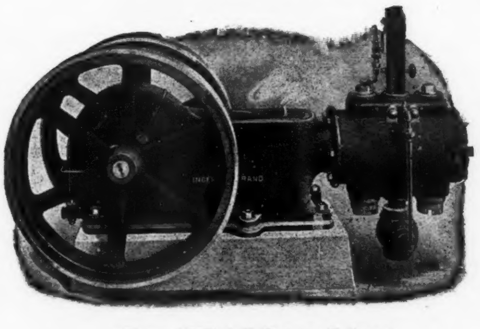

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McKiernan-Terry Drill Co.
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Pumps, Steam.
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Stearns-Roger Mfg. Co.
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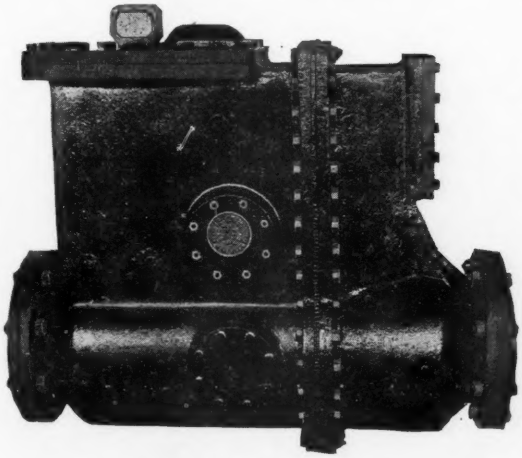

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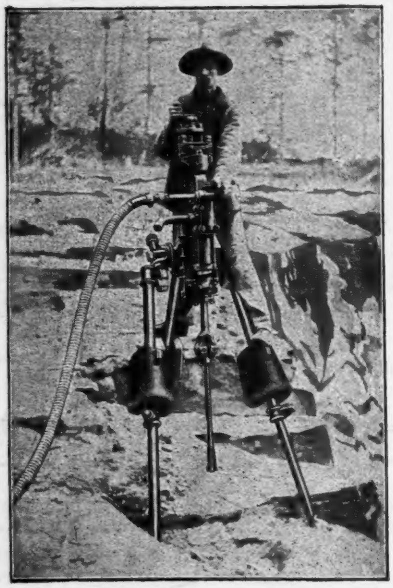

From a Mining Co. in Michigan

"For the past three years we have been using your Chicago Giant Rock Drills at our several mines. During this time they have given such excellent satisfaction and service that we have been disposing of our other drill machines and replacing them with the Chicago Giants, which in the future will be our standard machines. For operating efficiency and low cost of repairs, they exceed any machine we have ever used."

From a Quarry in New York State

"Having had a personal experience with nearly all kinds of steam drills, I find that the drills manufactured by the Chicago Pneumatic Tool Co. can drill more feet in a day and use less steam and less repairs than any other drill I know of."

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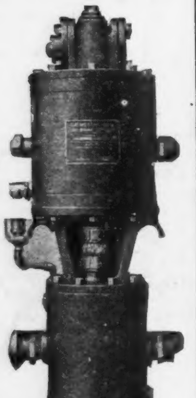

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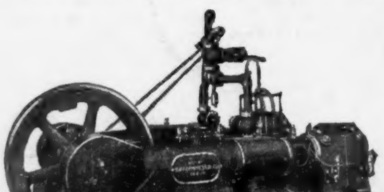

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